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Contents

Vision in Electronics — *A. B. Du Mont*
Application of electronics to all phases of everyday living will be tremendous in the future, as demonstrated by the introduction of television — 773

Tomorrow's Energy Requirements — *W. B. Tippy*
The future energy needs of the United States and the probable means of meeting these needs are discussed — 776

The Well-Integrated Man — *Philip Sporn*
Regardless of specialty or basic education, the well-integrated man represents the best prospect for personal happiness and individual contribution — 780

Testing for Safety—*Safely* — *J. A. MacNabb*
Prevention of accidental injury to personnel and damage to property is an important concern in the operation of an electrical laboratory — 784

Nikola Tesla—*Pathfinder of the Electrical Age* — *K. M. Swezey*
In observance of the centennial of the birth of Tesla, a summary of the great electrical inventor's accomplishments is presented — 786

Adapting a Trolley Coach System to a Changing Traffic Pattern — *S. M. Shockey*
A description of the approach used by Seattle's (Wash.) Transit Commission in dealing with a difficult traffic situation — 792

Beginnings of Switching Theory in the United States — *R. I. Wilkinson*
This history of our present-day telephone switching includes the first application of traffic probability theory — 796

Mechanized Tree Trimming — *J. Rasmussen*
Power companies using mechanized tree trimming equipment can make an average saving of $50 per mile, as proved by one utility — 804

Probability Calculations for System Generation Reserves — *Carl Kist, G. J. Thomas*
Past methods for determining generator capacity reserves seem inadequate, and it is apparent that this probability theory fulfills operating requirements — 806

Analogue vs Digital Techniques for Engineering Design Problems — *D. B. Breedon*
The important characteristics of analogue and digital computers are explained, using examples showing some applications of each type — 814

Power Regulation by Semiconductors — *F. H. Chase*
Semiconductor equivalents are replacing the electron tubes, magnetic amplifiers, and gas-tube diodes in many power regulation applications — 818

THE COVER: The core and pressure vessel assembly of Homogeneous Reactor Experiment No. 2 is shown as it was being installed below the shielding floor of its building at the Oak Ridge National Laboratory in Tennessee. Story on page 877.

CONTENTS CONTINUED

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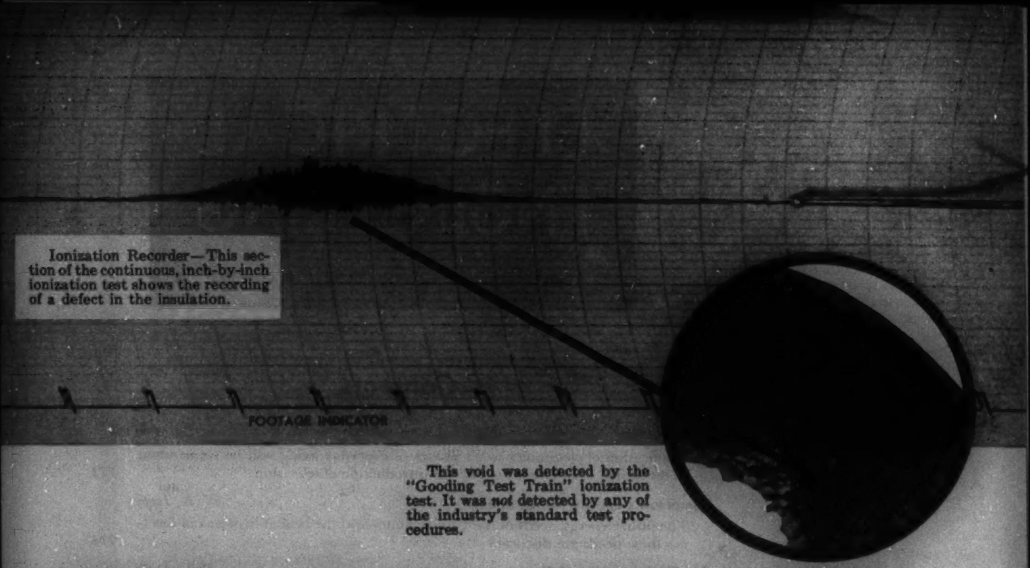


Ionization Recorder—This section of the continuous, inch-by-inch ionization test shows the recording of a defect in the insulation.

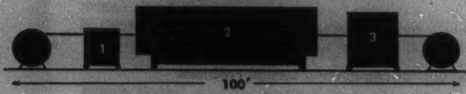
This void was detected by the "Gooding Test Train" ionization test. It was *not* detected by any of the industry's standard test procedures.

New Testing Procedure developed by Okonite

"Gooding Test Train" detects flaws in insulated power cable (2kv and over) heretofore unrevealed by standard tests

The "Gooding Test Train" has significant value to cable users. This new system of *non-destructive* testing, developed and used only by Okonite, reveals imperfections which are frequently not detected by ordinary testing procedures. Some of them even slip by Okonite's super-voltage a-c and d-c tests (highest used in the industry) and "full reel" corona tests.

The "Gooding Test Train" consists of a series of three test sets. The entire length of cable passes consecutively through each set as follows:



SCHEMATIC DRAWING OF GOODING TEST TRAIN

1. Uniformity Test—A uniformity gauge continuously checks insulation thickness—locating any thin spots which might cause premature failure.

2. Ionization Test—This is the most important unit of the "Gooding Test Train". It can measure the corona level at any spot along the cable. Procedure is to test the cable *inch-by-inch* at a predetermined voltage which is sufficient to assure the user that the corona level is at least 1½ times the rated voltage. Voids and imperfections as small as a grain of sand have thus been identified and removed.

3. X-Ray Test—X-ray inspection of the cable is performed by a 250,000 volt X-ray machine. This determines the nature and extent of any of the flaws indicated above.

By such intensive testing, it is possible to eliminate previously unidentified imperfections that might otherwise lead to premature failure. Studies of such defects also help to identify the cause and permit preventive measures. The "Gooding Test Train" is now being used to test all Okonite's rubber-insulated cables rated at more than 2000 volts. It is a long step towards securing the "perfect cable" and, as such, of tremendous benefit to cable users.

For detailed information about Okonite's G.T.T. write for new Bulletin EG-1100A, to The Okonite Company, Passaic, N. J.

where there's electrical power . . . there's **OKONITE CABLE**

Contents Continued

Technical Paper Digests

Minimum Cost Loading of Transformers *Arthur Klopfenstein* 791
Characteristics of D-C Rolling Mill Motors *E. P. Smith* 795
Transient Stability Angular Increment Computer *H. Wood* 803
Magnetic-Amplifier Control of Switching Transistors *H. W. Collins* 812
Centralized Power Control in the Steel Industry *W. A. Derr, W. L. Metz* 813
Simple Reactor Circuit Operation and Mode Transition *J. F. Ringelman, A. L. Fenaroli* 817

News Index

Institute Activities 823
- A Message from the President 823
- AIEE Fall General Meeting To Be Held October 1–5, 1956 823
- Over 2,000 Members and Guests Enjoyed Summer and Pacific Meeting 828
- Section Delegates Conference Considers Many Important Problems 830
- 65 Technical Sessions Held at San Francisco Meeting 832
- AIEE Board of Directors Summer Meeting Held June 28–29 835
- Special Task Committee Reports on New Engineering Societies Center 836
- New Prize Rules for AIEE Papers 837
- AIEE Future Meetings 839
- AIEE Officers and Committees for 1956–57 841
- Committees Reorganized under Five New Departments 857
- American Institute of Electrical Engineers Organization Chart—1956–1957 858
- AIEE Meetings Calendar 860
- Schedule of General and District Meetings 1956–1962 861
- Schedule of Special Technical Conferences—1956–57 862
- Committee Activities 864
- AIEE Personalities 864
- Membership 866

In Educational Circles 867
- Special Student Activities Held During Summer and Pacific Meeting 867
- Elk County Scholarship Winner 868
- Spokane Section Honors Professors 869

Of Current Interest 871
- "Honeycomb" Memory Stores One Million Bits in Inch-Square 871
- Development of Versatile Voltage-Tunable Magnetron Announced 872
- Future Meetings of Other Societies 873
- World's Largest Bulldozer Moves Crashed Bombers from Runways 875
- Nationally Co-ordinated Nuclear Energy Standards Set 876
- New Homogeneous Experiment Reactor at Oak Ridge 877
- Survey Pinpoints Some Reasons for Engineer Shortage 878
- Letters to the Editor 879
- New Books 880
- Pamphlets 880

Industrial Notes 14A
New Products 20A
Trade Literature 42A
Index to Advertisers 96A

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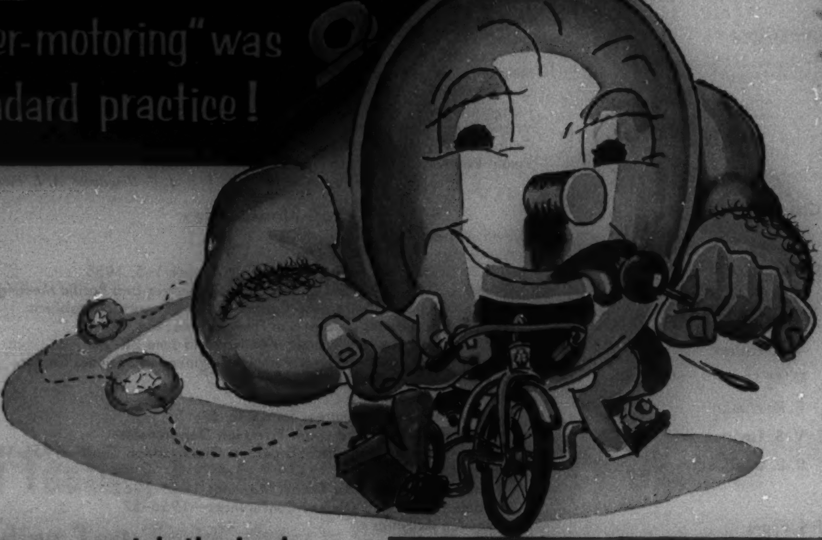

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Vision in Electronics

A. B. DU MONT
FELLOW AIEE

Possibilities for use of electronics in all fields in the future are predicted as being tremendous. Television has been an important factor in conditioning people so the attitude has changed from somewhat reluctant acceptance to eager welcoming of new electronic developments.

THE TITLE FOR THE REMARKS on "Vision in Electronics" gives two areas to explore: first, one can apply the word "vision" as meaning "looking at what is ahead of us"—in the art and the industry of electronics; second, a review can be given of a particular phase of electronics—that section in which there actually is vision or a pictorial presentation.

It is appreciated that all electrical engineers are not professionally connected with electronics as such, but since that is the basis of my experience, no deviation will be made.

Actually, electronics itself has become so specialized and changes have come so fast, that no one person could consider himself or herself an expert in the broad general field. The art is moving so rapidly that a particular program can be all set to go; then there will come a new technological development, and one may have to start all over again—this is particularly true with some of the advanced projects of the military.

The dictionary defines "electronics" as that branch of physics which treats the emission, behavior, and effects of electrons—especially in vacuum tubes, photoelectric cells, cathode-ray tubes, etc. To these should now be added transistors and other semiconductor units.

How old is the electronics industry? Actually, the word itself was not even in existence 25 years ago, when my work with the cathode-ray tube was started. Correspondence with Maurice Clements, then with McGraw-Hill Publishing Company, revealed his intent to start a new magazine dealing with electrons, tubes, circuits, and theory. He proposed to call the publication *Electronics*, and from the magazine's title came the name of the art. The word did not come into much general use until World War II.

As for what person or what invention is responsible for the electronics art, there were too many experiments, each building a little on what had gone before, to single out one man or one development. The *Encyclopedia Brittanica* says that "the progress of science takes place, for the most part, by a process of infinitesimal accretion." Electronics is such a science. Its emergence into today's $11 billion industry has been going on for centuries in which there has been added slowly small blocks of knowledge to what existed before.

Its present status, however, can be better likened to a massive thunder storm. It has been a long time building up, but now it is striking out brightly in every direction. The gathering of knowledge about electronics and its applications has accelerated so tremendously in the past 10 years alone that a new age has been entered—the electronic age.

INCREASED APPLICATION

THE INCREASED APPLICATION of electronic devices will extend man's capacity many thousandfold—and in some cases many millionfold.

To be specific—everyone is familiar with the fact that giant electronic computers can solve in minutes mathematical problems that an entire team of skilled men might require years to figure. All know of electronic payroll equipment in large concerns, which can perform the entire payroll function to the actual printing of checks—with a staff of only three or four persons. There are the completely unattended microwave relay setups for telephone and television relays—with electronic indicators at a central point immediately signaling if anything has gone wrong or is on the verge of failure.

Most everyone knows about the so-called DEW line—or distant early warning radar system—now being set up in the Arctic. All know vaguely how this system and other searching and tracking systems are tied in to SAGE (semiautomatic ground environment) for electronic, automatic searching, identification, and retaliatory action.

Essentially full text of an address presented at the AIEE Summer and Pacific General Meeting, San Francisco, Calif. June 21–29, 1956.

A. B. Du Mont is Chairman of the Board of Directors, A. B. Du Mont Laboratories, Inc., Clifton, N. J.

ACCEPTANCE

In almost every industry there is some acceptance and use of electronics—from the completely automatic machining and handling of an engine block in Detroit, Mich., to the small intercom system in a tool and die shop.

The uses of electronics are growing so fast that people no longer are astonished by its miracles. One reason that electronics can do the fantastic things which it does is that it completely bridges all existing concepts of time. In electronic devices, there are types of apparatus that perform their complete function in millionths of a second. Why? Because no part really moves—nothing moves but electrons.

Ordinary people, business management, and the military accept new miracles every day. You do not even find these miracles on the front pages of the newspapers anymore—they are buried on the business page or feature page. A radar signal is bounced off the moon, atomic submarines are built, atomic reactors for power plants are coming into being—all possible through electronic control. In our company, a device was recently announced that can actually count up to 1 million objects in a second. Also, an electronic instrument can instantly tell an auto mechanic what is wrong with the ignition system of a car.

Perhaps the very wonder of televison has been a factor in conditioning people to accept the almost impossible whenever it happens. During the past 10 years the attitude of businessmen and Government and defense officials has changed from somewhat reluctant acceptance of necessary electronic innovations to an eager welcoming of the most advanced research and development in the electronic field.

VALUE

Originally the main function performed by electronics was that of communications. Now the electronic age is witness to the fact that electronics can be one of man's most valued servants. It can control and regulate the dull, repetitive, unskilled, and semiskilled processes that previously had to be performed by humans.

No attempt is made here to discuss social readjustments that may be necessary as a result of the increased use of electronics and automatic processes. Some will have to be made. That is certain. In the over-all perspective, however, it must be recognized that America's material well-being, its standard of living, and the financial well-being of the average family have climbed steadily upward in direct proportion to our ability to produce more goods per man hour of labor.

NEW HORRORS

By the same token, just as all today accept new miracles with hardly a shrug of the shoulders—so, too, all accept new horrors. Nuclear energy has opened up a vast new source of power. Through electronics it can be controlled for peacetime use and greater abundance.

Electronics, however, is also the essential controlling element in all of the missiles being developed by ourselves and by Russia. Nuclear power in combination with electronics gives opposing nations the power literally to blast each other off the face of the earth with a push of a button.

In recorded history, there always has been developed some type of defense for every new offensive weapon. If that is the case in the missile field, it undoubtedly will be electronics that will play a major role in such a defense.

Our technical and material progress has been truly staggering in the past 50 years—in every branch of daily living, as well as in the military field. How tragic it is that human relationships between individuals and nations seem to have made practically no progress. And yet there must eventually be international understanding if we are to save ourselves from ourselves. Perhaps electronics can make contributions toward that end through world-wide television service and other forms of expanded international communication.

CATHODE-RAY TUBE

Applications of electronics that use the visual indicating device called the cathode-ray tube will be considered now. Through the cathode-ray tube, actual visibility is applied to electronics. It is the essential part of all devices that present an electronic picture. Included, of course, are television receivers, radar sets, Loran, and the instrument without which there could be no "electronic age"—that is, the oscillograph, or, as some call it, the oscilloscope or just plain "scope."

The very few scopes that were around 25 years ago used imported gas-filled cathode-ray tubes that were very sluggish and that provided qualitative rather than quantitative results. There were mechanical oscillographs in use, but their frequency was limited to around 5,000 cycles.

Over the years the cathode-ray tube has been so improved, so far as its accuracy of display is concerned, that now the scope is an accurate quantitative-measuring device, able to measure any vibration or oscillation that can be converted to an electric voltage.

As for frequency response, 30,000 mc is now being approached. Actually, it is safe to predict that the writing speed of the beam of an oscillograph can be increased in the near future to a speed faster than the speed of light. This will make possible the measurement of such extremely high-speed phenomena as nuclear reaction and radioactive scintillation.

There just is no other device in existence that can accurately measure the kind of high-speed phenomena found in electronics. But with this instrument, radar circuits, computers, television transmitters—each and every type of circuit—can be and are analyzed in wave form on the face of a scope. The circuits could not be maintained without the cathode-ray tube and the associated circuitry that makes it a "scope."

TELEVISION

Television itself as an entertainment and communications medium needs little elaboration. All have seen it sweep the country in just 10 years, to the point that 75 per cent of the families in this country have receivers. All have seen it make available in the living rooms of farm and apartment the finest in our literature and culture—and some of the worst. This one electronic device has wrought an actual revolution in America's living and leisure habits. At a somewhat slower pace, it is doing the same thing throughout the world.

There are, of course, many other vital television uses in addition to being a home entertainment instrument. With the military, for example, its use as a remote monitoring device is widely recognized. Television cameras can be carried in unmanned remotely controlled tanks, in drone aircraft for reconnaisance, used for checking gunner accuracy, and a tremendous variety of training purposes.

In industry, also, it is finding a tremendously broad area of application. Wherever observation at a distance can save money or prove a safety factor, closed-circuit industrial systems find ready acceptance.

Educational television is still in its infancy. Yet it is probable that in the very near future every progressive school system in the country will have its own closed-circuit system, so that the best available teaching can be brought to the largest number of students.

The field of medicine has already proved to be a prime benefactor of television and television techniques. Color television is particularly useful for illustration to students of operative techniques.

The possibilities for the use of electronics and television in medicine are really tremendous. Through an infrared pick-up tube, a medical ward in complete darkness can be under constant scrutiny.

In our laboratories, work is being done on an ultraviolet flying-spot scanning cathode-ray tube for the microscopic examination of living cells without destroying them. A new oscillograph is being designed for use by doctors during operations for the monitoring of the patient's heart action. It will reveal possible heart failure in advance and prove a decided additional safety factor.

Think of the many tests that must be made on a patient in a thorough physical check-up. Each requires someone to administer the test, and someone to interpret the result—it is an expensive and time-consuming procedure. It is expected that there will be made available in the future a comprehensive electronic device that will make many necessary medical tests almost instantaneously and that will furnish a complete visual presentation of most of the conditions vital to our health.

What then is electronics—and what is the vision for the future?

THE FUTURE

ELECTRONICS is the new "genie" which can serve man almost instantly in every field of human endeavor. The electron is basic to all matter in the universe. If it can be used wisely and in peaceful ways only, it will lead to new heights of material wealth, bodily health, and, through world-wide visual communication, greater human understanding.

Crystals Grown by Semiconductor Manufacturer

Battery of germanium- and silicon-crystal growers showing eight of the 20 units in operation in the world's largest installation of such units at the Texas Instruments Inc. (TI), Dallas, Tex.

Each of these units includes a TI-built crystal-growing assembly, induction furnace control, programming cabinet, and an Allis-Chalmers Manufacturing Company's 25-kw electronic induction heater.

In growing transistor parent crystals, ultra-pure germanium or silicon in an inert atmosphere is brought up to 960 or 1,500 C and surface of melt is held precisely at the freezing point.

The withdrawing of a seed crystal at a controlled rate causes growth of a mechanically perfect crystal the size of a plum.

Induction heating maintains temperature within a tenth of a degree during crystal-growing cycle, in spite of varying radiation and convection losses as crystal size increases. Crystal layers of different conductivity causing transistor action are created by the addition of minute quantities of impurity elements.

Twenty-two of these electronic induction heaters are used by this semiconductor products manufacturer for purifying and growing the germanium and silicon crystals, which are used in the production of diodes, triodes, and tetrodes.

Tomorrow's Energy Requirements

W. B. TIPPY

The future energy needs of the United States and the probable means of meeting these vital needs are discussed. It is necessary to find economical ways to supplement coal, oil, and natural gas deposits as they reach limits of expansion.

CONTINUOUSLY INCREASING quantities of energy are required for our rising standard of living, and there is little prospect that the economy can continue indefinitely to increase with the known energy sources, unless new techniques are discovered. The time to extend our thinking as engineers beyond present-day energy source patterns is upon us, if we are to accept the challenge to keep the standard of living on the rise.

Will it be atomic energy and a change in the country's energy absorption pattern to make full nuclear power development possible? Can synthetic liquid and gas fuels let us upgrade and recover low-grade coal and shale oil reserves? Solar energy could be important with the solution of technical as well as location and storage problems. Water power has been important but now remains a small factor in the total economy.

REQUIREMENTS

ELEMENTS which enter into making a forecast of energy requirements are summarized in Figs. 1 through 6. Population increase, energy use per capita associated with the rising standard of living, and improvement of efficiency in the use of energy combine to indicate total energy input requirements about three times the present values by the year 2000.

Use of this energy for work as contrasted to the needs to keep everybody warm will be the major factor in future growth of our energy systems. Fig. 2 is, in effect, a graphical presentation of what a higher standard of living looks like. The trend in this country has been from a subsistence

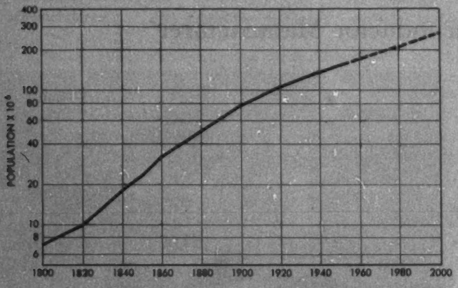

Fig. 1. U. S. population growth. Projections assume no major wars, depressions, or catastrophes.

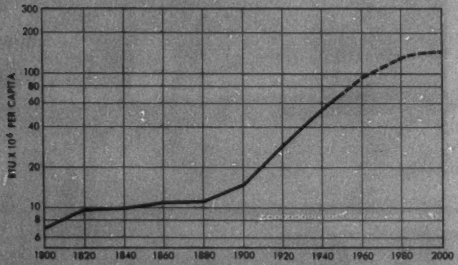

Fig. 2. U. S. energy output per capita.

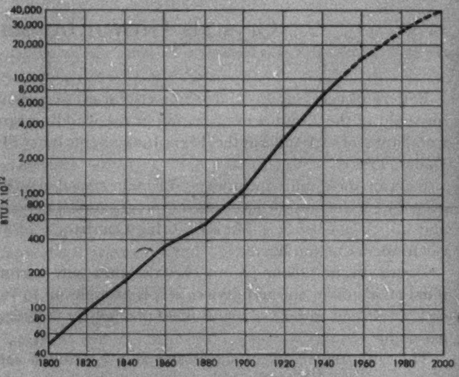

Fig. 3. Total U. S. energy output.

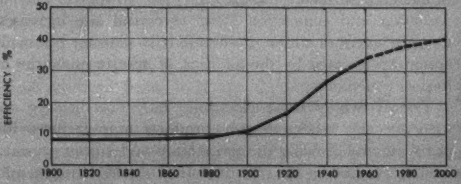

Fig. 4. U. S. energy system efficiency.

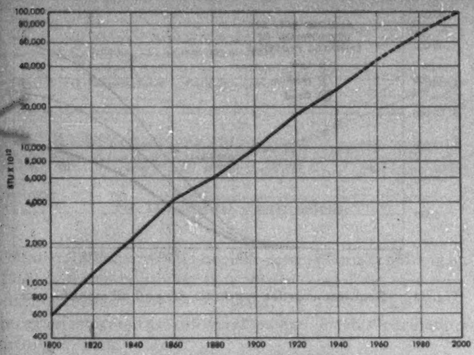

Fig. 5. Total U. S. energy input requirements.

farming economy to an industrial-urban-farm pattern of life. That this higher standard of living will continue to increase seems to be supported by many facts and present technological developments.

The total efficiency of the United States energy system has increased threefold since 1900, to a present figure of around 30 per cent. Continuation of this rate of increase does not appear likely—for example, electric generation has increased in efficiency from only 4.5 per cent in 1900 to about 23 or 24 per cent now, and it should go to 30 per cent by the year 2000. Efficiency of the total energy system during the last century was approximately that of a colonial fireplace. Efficiency of energy use for work including automobiles, generating plants, railroads and other forms, has increased to a present level of about 25 per cent or slightly more, and efficiency of comfort heating with central plants has increased to 50 per cent and higher. An over-all figure of 40 per cent may be about right for the year 2000.

We are at present in the range of a total energy use of 70 million Btu per capita. To have a scale for that amount of energy, it takes about 150 million Btu to heat a house in Michigan with gas for an entire season. The average residence has between 3 and 3.5 people but, of course, not all climates require as much heat for comfort as that in Michigan.

Use of energy for work (electric power generation, automobiles, etc.) will continue to increase for a rising standard of living, and is the major factor in the future growth of our energy system (Fig. 6). Growth in comfort heating will be proportional to population, with a small increase per capita necessary compared to the work energy per capita.

SOURCES OF ENERGY

THE SOURCES OF ENERGY available to us, expressed as percentages of the total energy supply, are shown in Fig. 7. This chart represents the elements of the energy system as they relate to each other competitively rather than as each

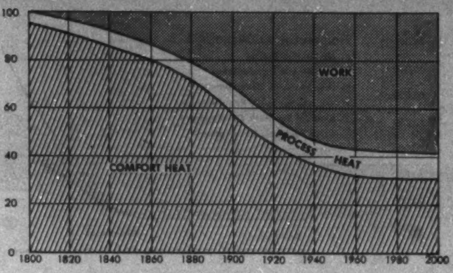

Fig. 6. Energy use (input).

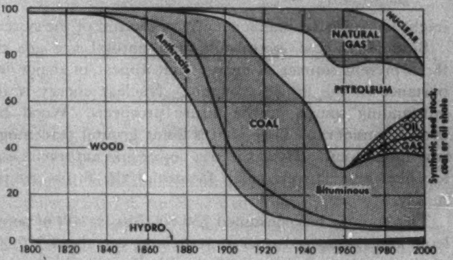

Fig. 7. Energy sources, actual and projected.

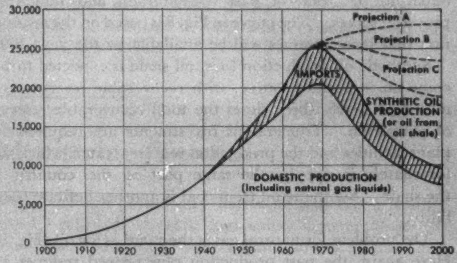

Fig. 8. Petroleum input.

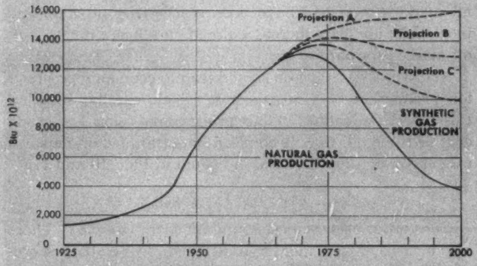

Fig. 9. Natural gas input.

Revised text of an address presented at the AIEE Michigan Section Meeting, Jackson, Mich., February 14, 1956.

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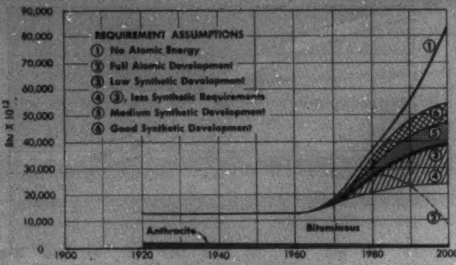

Fig. 10. Coal input.

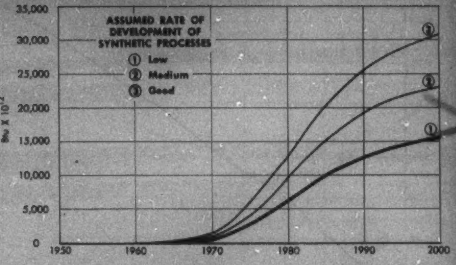

Fig. 11. Requirements for synthetic gas and oil manufacture.

might be estimated independently of the rest of the system.

Bituminous coal, petroleum, and natural gas are the three present sources of energy that appear of major importance in the future economy. Nuclear energy is the outstanding source in the future prospects. Wood has been a considerable factor but is losing ground percentagewise to the total. Hydroelectric power and anthracite coal are likewise relatively small factors in the future energy supply.

This country has consumed 330,000 Btu × 10^{12} of petroleum and the proved reserves remaining are about 210,000 of these units. Estimates of the "indicated ultimate reserves," which have been made by several authorities, indicate that there is yet to be discovered an amount about equal to the total of past consumption and remaining proved reserves. The curve in Fig. 8 is based on the assumption that these reserves will be available by the year 2000.

Synthetic oil production from oil shale is expected to become an important source, with recoverable reserves estimated at nearly three times the total recoverable reserves of petroleum. Tremendous investments are required for plant facilities and the production requires water, which unfortunately is not in the same part of the country as the shale. Synthetic oil from coal is another definite possibility.

The problem for natural gas is the same as for oil (Fig. 9). Here again, the past production plus proved reserves account for about one half of the estimated ultimate recoverable reserve of gas. The maximum growth period for the natural gas industry is coming to an end, partly because all markets soon will have been reached by pipeline and partly because price increases already are beginning to shut off markets for natural gas.

Research now going on should lead to economic processes for production of synthetic gas, which can be supplied through the pipelines. This production, using low-grade coal or shale oil, may become an important factor, depending on competitive angles as indicated in Figs. 10 and 11.

COAL—THE BALANCE SOURCE

Coal is our present most abundant energy source. There is some area of agreement that assumed recoverable reserves of coal may be around 7.5 million Btu × 10^{12}. Actually there may be as much as three times this amount but a large part is believed not to be recoverable on an economic basis. Of the assured reserves, 1.9 million Btu × 10^{12} are east of the Mississippi River; this is about twice the total amount burned in the whole country since mining was started. A large part of the coal in the West is very low grade, with considerable ash and impurities, and some of it is subject to spontaneous combustion and cannot be stockpiled.

A wide range of assumptions must be made to project possible requirements in the use of coal as indicated in Fig. 10. Curve 1 shows the maximum use of coal if atomic energy is not available; curve 2 represents the other extreme, i.e., if "full atomic development" took place. Probably neither of these extremes will be the case and curve 3 may be more nearly in line with some developments in both atomic energy and synthetic production. Fig. 11 shows the possible requirements for use of coal in synthetic gas and oil manufacture, again with the range of suggested possibilities.

NUCLEAR ENERGY FOR GENERATION

Because of classification problems, little information is available, but it has been estimated that low cost uranium and thorium could provide 100,000 Btu × 10^{12} a year for several centuries. This is equal to the total amount of energy input required as projected for the entire economy in the year 2000 (Fig. 12).

There appears, then, to be little question of an adequate supply of nuclear energy for electric generation, but power plants now use only about 10 per cent of the total energy input. It might be possible without radical changes in the energy system of the country to increase this to 20 per cent, but electrification beyond that point does not appear in the present thinking. This figure is used for the year 2000 in building up the curve of Fig. 7, wherein the principal use of atomic energy is assumed to be for the generation of electricity.

The total curve of power plant capacity in Figs. 13 and 14 is based on a 7 per cent annual rate of increase. It is necessary to make a number of assumptions, particularly as to costs, in arriving at the percentage of new capacity which will use nuclear energy. It has been estimated that technological improvements will reduce the generating cost to 6 or 7 mills by about 1965 and to 5 mills by 1980. If these price assumptions are at all correct, we might expect

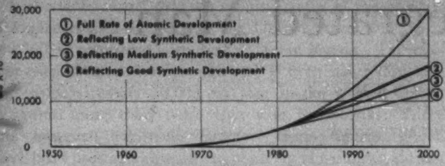

Fig. 12. Nuclear energy output.

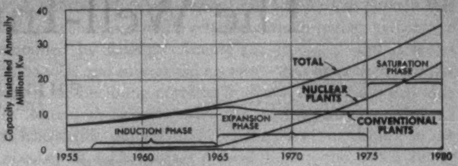

Fig. 13. Power plant capacity installed annually.

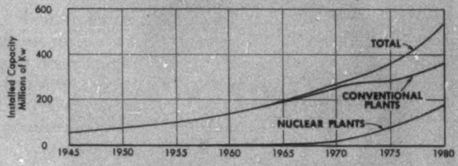

Fig. 14. Installed power plant capacity.

considerable expansion in nuclear power plants beginning in 1965, with the possibility that 60 per cent of the new generating capacity might be nuclear by 1975. This is the program indicated as "full development" for this speculation on future energy sources.

Fig. 14 shows the cumulative effect of the annual increments of Fig. 13. Total power plant capacity of the country by 1980 is expected to be about five times the present capacity, or around 542 million kilowatts. After some consideration of the other energy possibilities, a fair estimate of installed nuclear capacity may be around 100 million kilowatts. This is a little over half the full development considered possible. It is shown as curve 2 in Fig. 12 and corresponds to projection C in the synthetic development curves.

ENGINEERING IS THE KEY

Engineering is the big problem in the atomic power field today, with the nuclear physics in general, being fairly well understood. Reduction in the cost of nuclear power involves many elements in design, fabrication, reprocessing, metallurgy, temperatures and pressures, waste disposal, and safety. These primarily are engineering problems and their solution is the real test ahead for nuclear development.

Nothing is fixed in our view of the future. The parts to be played in the future by coal or shale oil depends on possible new developments, just as in the case of nuclear energy. They are all capital energy sources and cost will determine their relative relationships. Solar energy could become important, along with wind, tide, waves, thermoelectric effect and other effects which produce income energy, but they appear to be minor in comparison to nuclear and our present sources of energy.

Self-Checking Fail-Safe Monitoring Systems

Successfully tested on fire-detection systems, machine safety controls, furnace-flame monitors, photocell intrusion alarms, and liquid-level controls, a new dynamic monitoring technique, which checks itself by a unique pulsation method, has been developed by the Scully Signal Company of Melrose, Mass. This fail-safe method requires few additional components to change conventional static systems to the new dynamic self-checking design. The technique is sufficiently basic to be used with electronic, electrical, mechanical, pneumatic, hydraulic, and nuclear systems.

Shown inspecting the controller are W. G. Rowell (right), its inventor, of the Scully Signal Company, and E. A. Dubois, supervisor of building services for the Polaroid Corporation. This furnace flame monitor consists of a torch unit, held by Rowell, and a panel-mounted circuit, being checked by Dubois. The new system has proved itself ready for general application to automatic systems after 15 months of continuous trouble-free operation in the film plant of the Polaroid Corporation.

Among the many fields of application for this device are burglar and fire protection; industrial and home heating control; railroad, aircraft, and safety systems; process-control instrumentation; and a multitude of military and atomic energy protective systems.

The Well-Integrated Man

PHILIP SPORN
FELLOW AIEE

On occasion of his being honored with a degree in Humane Letters, the author in a commencement address states that the well-integrated man, whatever his speciality or basic education, represents the best prospect for personal happiness, as well as for individual contribution to the common good.

THIS OCCASION can best be used to discuss a question that is one of the most critical that confronts the United States today, which is the scarcity of scientists and engineers.

My own predisposition is scientific, though first being trained as an engineer and later becoming an executive. My conviction, however, is that one best serves himself and others to the extent that whatever he may be he is also a humanist. This is said by way of explaining my general outlook.

MODERN WORLD IS THE WORK OF THE ENGINEER

THE WORLD OF TODAY—the world that has evolved in our modern industrially advanced societies—is in considerable measure the work of the engineer. Certainly it is so in the United States. But the engineer is almost never a discoverer—his base is the work and the findings of the scientist. Starting with these and with the resources of nature, he shapes and transforms them to practical use.

In its peacetime aspects, this work is constructive—from it has come more and better food, clothing, shelter; more extensive and better education; more extensive and better communication; widespread entertainment; and a general amelioration of the conditions of living.

In its military aspects, the work of scientist and engineer has resulted in instruments of destruction of terrible power, which at best can be regarded as deterrents to war or as means of defense.

If all that is gained is a world that is less than perfect, still there is no salvation in a return to the conditions preceding the era of the engineer. Even in the areas that enjoy a high level of economic welfare and physical comfort, there is need for more industrialization, utilizing more mechanization. In that process, there will always be required the application of more mechanical and electric power and energy with the objective of further increasing production and productivity. But if this is a desirable goal in the industrially developed countries, in the less developed countries it is a necessity.

COMPARISON WITH RUSSIA DISTURBING

ALL THIS MEANS more and better engineers and scientists. In the United States, there is currently a crisis because of a shortage in the present and future supplies of both groups.

The immediate cause of our difficulty is, of course, our failure to train enough of our youth in these two fields. Of late, disturbing comparisons have been made of what is happening in the United States with what is happening in Russia. A subcommittee of the Joint Committee on Atomic Energy of the U. S. Congress has recently studied the question. It has issued a report, pointing out that the United States is in desperate danger of falling behind the Soviet world in this critical field of competition. The President of the United States only a short while ago called attention to the fact that our technological superiority is now seriously challenged by those who use science for aggression and conquest. He has therefore established a national committee for the development of scientists and engineers, and has named the head of one of our leading universities as chairman of this committee.

Essentially full text of an commencement address presented at Marshall College, Huntington, W. Va., May 28, 1956.

Philip Sporn is president of American Gas and Electric Service Corporation, New York, N. Y.

It should be noted that the relative status of the number of engineers and scientists in the United States in 1956 is 760,000, as compared with the 890,000 in Russia. The current rate of education of engineers is even more disquieting—approximately 30,000 per year in the United States, as against more than twice that rate in Russia. There are, however, offsetting factors: these figures, which have been used so frequently to point up our danger, do not take sufficiently into account the difference in the quality of our engineering graduates and the lesser prevalence here of the narrower training and overspecialization, which seems to be the case in Russia. Also, the same accounts, showing Russia is producing so many well-trained scientists and engineers, report so few social scientists and humanists. There is reason to hope, too, that the disadvantageous gap between Russian and our engineering manpower can be bridged by using our engineers more effectively—or as one student of the subject puts it, by getting twice as much productive engineering per engineering man-hour.

But there is no room for complacency. There are, for example, reliable reports that the Russians have synchrotons, an immensely expensive and essential tool for basic scientific research, that are the equal of, if no better than, those we have here. It must be assumed that the Russians can do very fine work, at least, in some technical fields.

On the other hand in the area that is best known to me—that of electric power production, transmission, and distribution—the Russian achievements, according to reports believed to be reliable, are impressive but considerably behind our own. Moreover, the work that they are doing in this field reveals an investment of engineering manpower far greater than should be necessary to accomplish the results that they are getting. In short, while they may have more technicians, one gets the impression of prodigal waste in their employment.

ENGINEER SHORTAGE CRISIS IN U. S. IS IMMEDIATE

But after taking full account of our advantages, the fact is that in the United States there is a shortage of scientists and engineers of quality, who are capable of turning in skillful performances and of carrying out their work on a high level of creativity. In this respect the crisis is immediate; for the future the crisis is even more grave. There is a threatened marked deceleration in the rate of scientific and technological progress that has been counted on as an uninterrupted phenomenon; it is this that should be of most concern.

In the United States, at the present time, each year approximately $2^1/_2$ million boys and girls reach the age of 18; about one person in five starts college; and one in eight gets a degree. The approximately 23,000 bachelor degrees in engineering in 1955, plus the additional 14,500 in physical sciences and mathematics, made up about 13 per cent of our graduates with first degrees in all fields. This is a substantial proportion, but not the percentage that is needed to maintain our present scientific and industrial position. It certainly is not the proper proportion, considering the growth in importance of science and engineering in our world with each year.

A number of reasons have been adduced to explain this low percentage and the relatively much higher percentage obtained by Russia. Among the troubles—and it seems to be solid and substantial enough—that have been brought out is the declining percentage of our young boys and girls in secondary schools who get high-quality training in mathematics, physics, and chemistry and the decline in the number of such courses offered them; the much better situation in Russia has been explained on a number of grounds, including the teaching of Russian children that mathematics, for example, is fun.

Fear, in terms of the danger that Russia will outstrip us, is not the paramount consideration. Regardless of Russia, our needs require that the crisis of scarcity of technicians be solved. The pace that the Russians are setting and the general threat that Russia represents serve rather to emphasize our immediate deficiencies.

Without question, our present and prospective shortage of engineers and scientists with time will be materially lessened. Immense unfilled demands alone for technicians will create an increasing supply in coming years; indeed, signs of it are clearly here. Young men and women have been and are going to be even further stimulated to enter these professions for the simple reason that they know the demand for their services will be so great that they can count on fine opportunities and at least financially rewarding careers. The very fact of present and prospective shortage is also creating the conditions necessary to better meet demand in the form of such measures as the President's committee, which has already been described. Business, industry, and the professions, the universities, and other educational groups are all mobilizing to find means of providing the trained teachers, improved curricula, adequate physical plant, and scholarship money, that must be provided to yield the larger numbers of needed scientists and technicians.

ENGINEERS AND SCIENTISTS NOT WELL INTEGRATED

But if measures presently under way or in planning go a long way toward reducing or even, perhaps completely, curing the shortage of scientists and engineers in terms of numbers, that would still solve only a part of our problem. There is another problem which in the long run may be of even greater importance, and there are few signs that ways are known of how to cope with it. On the whole, our engineers are better in quality than those the Russians are producing—but this is a relative judgment. By and large, our engineers and scientists, in common with other segments of our society, are not well-integrated people. The pressure toward specialization is tending to produce men and women well disciplined in their specialities, but not well rounded as human beings. There is danger that the additional pressure now to turn out more and more specialists to cure the shortages will, if not countered in some way, aggravate this tendency.

Also, the people whose basic education or training is in the arts or humanities are not too well integrated either. Their difficulty stems from their failure in this modern world to understand: its deep roots in science; the rate of expansion and accrual of scientific knowledge; the dependence of a modern democratic society on technology and technological development to maintain its members at the high level of welfare, accepted as an almost indispensable testimonial of progressiveness and social consciousness.

Since the well-integrated man, whatever his specialty or basic education, represents perhaps the best prospect for personal happiness, as well as individual contribution to the common good, the remainder of my remarks will be devoted primarily to this problem. Although, it is difficult to offer a full solution, there are certain ideas which might contribute to its solution.

EDUCATION BECOMING FRAGMENTED

It is not too difficult to find at least some of the causes contributing to the development of the nonintegrated man. At the lower levels of education, that is in the upper grades of grammar school and in the secondary schools, there has taken place a diffusion of training into unimportant side channels and a lowering of standards of scholarship and performance. In the upper levels, that is in our colleges and technical schools, there has been a concentration and narrowing of the beam of instruction and interest. Thus, education has not only been fragmented into narrower fields of science and humanities, but also in each of these, further fragmentation has been carried out; this fragmentation has brought with it ignorance of many areas in related fields of knowledge, misunderstanding, and unhappiness. The effects of this fragmentation have been manifest enough in many cases. From the standpoint of the student body, fragmentation may discourage rather than attract the best of our young people into some of these narrowed, though exciting, fields. This is especially likely of that important segment of our youth of potentially high ability, but without sharply focussed interest, who, at the undergraduate level, could with wise training and guidance be brought into the scientific and engineering fields with great benefit to everyone.

The unfortunate consequences of fragmentation in education are everywhere to be observed. This problem was discussed by me some years ago with one of the outstanding personalities in England, the scientific advisor to the then head of the government. He recounted an experience he and a number of his colleagues had in a discussion with a group, members of Parliament, almost all of whom had been educated in the humanities and some at leading institutions. This discussion had wandered over to one of the lounge rooms in Parliament. It was a hot and humid day, and the bottles of beer that were being poured into glasses were showing on the outside the effects of warm humid air reacting against a colder glass surface. One of the more learned members of Parliament who was deprecating the failures of scientists and technologists, finally, to point up his argument, said "I would think a lot more of what you fellows might be able to do if you would first, for example, learn how to do a simple thing like making a bottle that won't leak."

Perhaps this learned member of Parliament was spoofing, but there is another story in which there can be no ambiguity of interpretation. One of our distinguished generals, who was connected with the Manhattan District, has told of some of the frustrations in the early days of trying to build the unprecedented large plants necessary to produce the fissionable materials for the first atom bomb. The general was on a tour of inspection, walking with an eminent physicist who was complaining about the time it was taking to build the physical plant. They came across some craftsmen, including bricklayers who were laying brick in carefully designed cubicles to house complicated electric equipment; these bricklayers were looking at drawings as they were laying their brick. This was too much for our scientist who exclaimed, "The trouble with this whole project is that there are too many engineers; there are too many drawings. If you really want progress, just give me the bricklayers and I will show them where to lay brick." To complete the circle, in the same project one of the top engineer's solution of the problem was equally simple, "Just get rid of the longhairs," he advised the general, "and the job will get done."

HUMANISTS AND SCIENTISTS BOTH SEEK RECOGNITION

The difference of outlook between men of letters, the humanists on the one side, and the scientists and engineers on the other side, and even between the scientists and engineers—this all-around intolerance on all sides and the failure to appreciate the dignity and worth of those on the other side—is one of the disturbing phenomena of our times. In many cases, it results in an inability of men in the different groups to appraise, because they do not really understand, the work of others. Sometimes they do not understand and appreciate the full value of their own work. One of our important physicists recently complained of the low position of science in the esteem of the layman, in government, and even in the universities. The dignity of science itself, he pointed out, is decreasing. And the humanists, in spite of the special position which they believe they have in spiritual matters, really feel left out of the world of today. Among the engineers, many of them feeling that they are directly responsible for the functioning of the engines that create today's wealth and well being, large numbers still have an inner unrest and dissatisfaction over the fact that they have not been given the recognition by the people in general for what they have achieved.

The scientist is certain that, in his search to find out the mysteries of nature, he is engaged in the one worthwhile human activity, and that his is the one field where the results of man's efforts are cumulative and progressive. This is the phenomenon of time binding, first described by Korzybski. The humanist, frequently repelled by this air of self-proclaimed importance, asserts the narrowness of scientific endeavor, with its tendency to destroy beauty and mystery. And both the scientist and the humanist can, and frequently do, join in looking down at the engineer as merely a wielder of a pair of pliers and a monkey wrench or, at the best, one versed in the manipulations of the slide rule. The engineer, confident of being the only one who understands the world he has put together, too frequently looks disdainfully down on the humanist as well as the scientist.

Conflict and misunderstanding, apparently unavoidable, create frustration in science, humanism, and engineering.

Culture and education—that is true humanism—cannot be allowed to become the exclusive property of any one group; if they are good, they are good for all men. If science is fundamental in our modern world and if engineering is indispensable to the world of today, then all educated men and women must be given some knowledge and appreciation of science and engineering. Also, all must gain a sufficient understanding of art, literature, philosophy and religion, regardless of their specialities, so that complete understanding becomes possible among all educated groups.

With appreciation of the dignity and worth of all phases of knowledge, the judgment exercised by individuals in selecting a special field of endeavor would not be warped by fears that their life as a whole, as well as their spiritual life, will be thwarted because of the supposed narrowness of activity characteristic of any one of the dozens of specialized branches of science or engineering.

MAN'S INTEGRATION MUST START EARLY

How CAN ONE go about nurturing this integration necessary to produce well-rounded men and women? It seems that one of the more important factors is the need to start in early—much earlier than has generally been thought necessary. The concept of the integrated human being needs to be adopted as the guidepost in the entire system of education, starting as early as the age that children begin to read and write. With the development of the ability to read and write, with the absorption of their first ideas in literature, music, and proper behavior, which is the beginning of their humanistic training, children can and should be taught their first science and, soon after, simple ideas in engineering. As they grow and develop, the work in all fields should be increased, progressing from the very simple to more complex ideas. Teaching along these broad lines should build a balanced knowledge, understanding, and appreciation, not only of accepted ideas of living and conduct, of the beautiful and aesthetic, but of the relationship of science and engineering to the world. If this has not been done heretofore, the fault is because of a failure to realize how much, of that considered advanced knowledge, can be taught the smallest children, if they have the intelligence and if teaching is characterized by sympathy, expertness, and enthusiasm.

If this work is done well at the grammar school level, it can be built upon solidly at the secondary level. At that point, just as the teaching of music is enhanced by performance in ensemble and in solo, as well as teaching of the drama by production of full-scale plays, so science and engineering can be taught by model and by experiment. The spirit of science and engineering, the spirit of search, experimentation, demonstration, and triumph can thus be implemented; and the spirit of excitement about a life built on activity along these lines is generated.

A critical item is the teacher; not men and women who know how to teach science and engineering, but men and women trained as scientists who also have a grounding in literature, art, history, and philosophy. Also, those who are to teach the humanities must have a solid understanding of the growth of science and engineering, their influence on human affairs in the past, and their potential influence in the future.

Teachers of this kind are easy to ask for, but getting them is another matter—the most difficult of all. Thus, as much diligence must be used in producing them as in curing the shortage of scientists and engineers.

A program of education on a broad front, carried through the first two stages of young people's schooling, will give finer and better developed material for our colleges and scientific and technical institutes. It will also help bring forth the young people whom Michael Pupin, one of the great scientists and teachers of the past generation, had in mind when in speaking of potentialities of achievement in engineering said, "Give me a boy with a three-dimensional mind, with an aptitude in mathematics and a love for Shelley, Mozart, and Wagner, and I'll pit him against any other boy in the world."

At the undergraduate schools of arts and humanities, the idea of the integrated man cannot be dropped. If the work has been done well at the grade and secondary school levels, not as much work toward this end may be necessary as in the case where these have been done more superficially. But certainly if the ideal of integration is to be achieved, courses should be offered and required dealing with the basic sciences and the fundamentals of engineering. In the sciences: anthropology, astronomy, biology, chemistry, mathematics, medicine, physics; in engineering: materials of engineering; energy-conversion, transmission and application—most, if not all, of these subjects need to be incorporated in the schools of arts and humanities in any program leading to sound education.

Where scientific or engineering study is pursued directly after leaving the secondary school without the benefit of undergraduate work in the humanities, the humanities need to be similarly covered either in parallel with the scientific and engineering studies or with at least one year primarily dedicated to their purpose; and with the humanities there needs to be included a series of courses on socio-economic relationships and evaluations.

Parts, at least, of the programs that are advocated have already been adopted and excellent experience gathered in certain secondary schools, schools of arts and humanities, and some schools of science and engineering. What has been attempted here is to show the need to go back even farther than the secondary school and to go deeper into science and engineering, both at the secondary school level and the undergraduate level in the schools of arts and humanities.

Such programs will enormously widen the source and greatly increase the yield of human material, capable of being trained in science and engineering and capable of enjoying that most rewarding of experiences—enthusiasm in one's work. Above all, such programs can help weld together our presently fragmented segments of educated society and make our society not only more productive, but also one in which individuals in each discipline will have greater appreciation each of his own worth and that of his colleagues, as well as the worth of his fellow men in other disciplines.

Testing for Safety—*Safely*

J. A. MacNABB
ASSOCIATE MEMBER AIEE

The operation of any electrical laboratory entails certain hazards. Methods used for eliminating many of these hazards at the new Underwriters' Laboratories testing station are outlined.

PREVENTION of accidental injury to personnel and damage to property is obviously an important concern in the operation of any electrical laboratory—whether industrial, commercial, educational, or experimental. It is not surprising, considering the nature of electric power and equipment, that such establishments are, almost without exception, inherently hazardous. By adherence to sensible precautions and operating procedures, these attendant hazards can be reduced to a reasonably safe degree.

The testing program at Underwriters' Laboratories, Inc., is particularly dangerous by virtue of the basic premise that every product tested is necessarily suspected of representing a potential fire or accident hazard. The products are often operated at some condition of overload, for continuous operation, or to breakdown, and sometimes subjected to deliberate abuse. In other laboratories the usual quest is to determine the way a product performs, or how effectively it performs, whereas at Underwriters' Laboratories the question always is "How safely does it perform?" This factor necessitates constant unrelaxed caution by laboratory workers with respect for the dangers in the product under test as well as in test equipment. With such perils to be faced, it is necessary that the laboratory and test facilities be specially appropriate to such operations.

ELEMENTS CONSIDERED

Building Design. Because safety is the business of Underwriters' Laboratories, it is only natural that the new testing station at Santa Clara, Calif., was carefully designed to include a laboratory where the testing of electrical equipment can be carried out with all possible safety. The layout of test areas and circuits and the design and installation of test apparatus were planned so that daily work might be performed under conditions most favorable to protection of life and property.

The building itself is of the most modern fireproof construction and materials, completely sprinkler protected, well lighted, and architecturally of a clean-cut character that encourages good housekeeping, all of which are important in establishing a safety-conscious atmosphere. Wherever possible, stationary equipment has been flush mounted. All switchboards, panel boards, and test panels are of dead-front design.

Test Voltages. Because of the wide variety of equipment tested, the test voltage may have to be any one of the many available from power systems throughout the country today. A test transformer is provided which has low-voltage taps at all of the popular voltages. By means of a dead-front switching panel, it is possible to distribute any of these voltages to a test panel in each test area. In addition to a saving in setup time, this eliminates much additional equipment otherwise necessary to raise or lower the test voltage. The resultant simplification of the test circuit reduces the number of components that contribute to accident hazards.

Receptacles. Because of the accident hazard involved in routing cords and cables from outlets to the points where power is required, a generous number of outlets are installed around the periphery of the main laboratory, on work benches and in special test rooms to minimize the necessity of temporary extensions. When the need arises to utilize for test purposes areas now used otherwise, it will be possible to install additional outlets connected through existing cellular floor and wall raceways. This feature will preclude, to a great extent, the necessity for exposed cords at any later date.

All receptacle outlets are of standard design corresponding to the voltage and current ratings of the circuits on which installed, to prevent errors in operating equipment or meters on improper voltages; for example, parallel-blade receptacles are restricted to 120-volt a-c circuits, tandem-blade receptacles to 240-volt a-c circuits, and the large so-called range-type receptacles of crowfoot design to 3-wire 120/240-volt a-c circuits. Similarly, other distinctive receptacle designs are used exclusively on d-c circuits. With this multiplicity of power outlets, a circuit of proper rating is available at the location where it may be necessary to set up a test.

Interlocks. Electric shock is a serious enough hazard when it is the primary cause of injury, but reflex action resulting from contact with an uninsulated current-carrying part may cause severe injuries, especially where the worker is using tools in confined spaces or in precarious locations. To minimize such shock hazards, it is imperative that there be no exposed live parts available to accidental contact either when making connections to or alterations in a circuit. To meet this problem, terminals at test panels are located behind interlocked doors which automatically de-energize the circuit when the doors are opened.

This same feature is carried over to the high-voltage dielectric test equipment; the product under test, as well as all

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Full text of conference paper CP56-669, presented at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

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The author wishes to thank his associates for their many helpful suggestions and comments in the preparation of this article.

uninsulated clips and terminals, is located within a protecting cage. When the door to this cage is opened, the circuit to the primary of the test transformer is interrupted. When necessary to work on a circuit on the line side of any interlocks, it is possible to lock the controlling circuit breaker at the main panelboard in an open position.

Grounding. The grounding of all appliances and equipment under test precludes the possibility of shock in the event that normally dead-metal parts, such as housings and enclosures, become energized. This practice is routinely followed in all test work. Suitable grounding lugs or terminals are available at all test panels to facilitate the grounding connection, and all receptacles, if appropriate, are of the design having a grounding blade.

Emergency Switches. In the event of an emergency in which it suddenly becomes necessary to turn off a circuit, push-button disconnects, intended for such use only, have been placed at strategic locations throughout the laboratory area and at the entrances to special test rooms. These remote-control emergency switches are so placed that no stationary or portable equipment will at any time obstruct easy access to them. Where the necessity for immediate shutdown involves a person in distress, there must, of course, be someone else present to operate the emergency disconnect; for this and other reasons, it is a rule that no one person ever works in the laboratory area alone.

Special Test Areas. There are a number of special test rooms in the laboratory particularly suited to certain types of test activities. Of these, two of the most important are the "burn-out" rooms, where tests are conducted which are likely to result in fires or emit large amounts of smoke. These rooms have concrete floors, a filtered exhaust fan to carry off fumes and smoke, and are protected by sprinklers in the event a fire cannot be readily extinguished. The equipment under test can be fully closed off, but can be observed through safety-glass doors; de-energizing of the panel within the burn-out rooms can be accomplished by a disconnect control located on the outside. For the control of any fires which might develop, suitable fire extinguishers are available outside these rooms. These test extinguishers are independent of the building extinguishers, all of which are checked periodically and after each usage.

Warning Signs. In unattended tests involving arcing contacts or moving parts, adequate shielding is employed as a safety measure. An indication that such tests are in progress is furnished in the form of readily legible and conspicuous signs specifying that the equipment is under test. Suitable warnings of this type are especially desirable if the action involved is intermittent, usually where the test is a function of time or temperature. Likewise, appropriate signs are used to call attention to tests involving high voltages.

Special Clothing. Certain of the tests conducted necessarily involve manual disconnect of current-carrying parts, such as in an overload test of appliance or flatiron plugs. From experience, it has been found that such tests can result in considerable arcing and emission of molten copper. As a precaution against such failures, the person performing the test wears heavy leather gloves and a substantial face mask, similar to the type worn by welders. Experience has also shown that such arcing, once started, is sometimes capable of sustaining itself. To de-energize the supply circuit under such conditions, a second person is stationed in readiness at a disconnect switch.

Hydrostatic Tests. Hydrostatic tests on components of refrigeration systems and other vessels are potentially hazardous if all air has not been forced out of the system or if there is a sudden rupture. Extreme care is exercised to insure that the water introduced into the test system and apparatus displaces all air. In addition, the sample being tested is located behind a suitable barrier.

Thermocouples. Several precautions must be observed where thermocouples are used. If the junction of the couple is located in the vicinity of live parts, it is carefully secured to prevent the bare junction from becoming dislodged and contacting the energized part. Occasionally it is necessary to measure the temperature of an uninsulated live part. In that case, the insulation of the thermocouple wires is carefully checked for fraying or other wear and the insulation must be known from experience to be suitable for the voltage involved. At the thermocouple selection switch, the live couple is isolated from other couples by leaving one connection position unused on each side of it to avoid a flashover or short circuit during operation of the selector switch. These same precautions are taken when attaching couples directly to coil windings insulated only by enamel. In the test work of motor-operated tools and similar rotating appliances, the thermocouples exiting from the housings are positively routed away from any moving parts to prevent sudden entanglement with such parts. This same rule applies also to meter leads, cords, and other wiring in the vicinity.

Hot Oil. Test work on appliances which use cooking oil in their operations presents a very serious potential fire hazard. In some designs of commercial cooking equipment, a substantial quantity of oil is often involved; if allowed to overheat, the oil can cause a brisk fire which may be difficult to control. During the initial portion of the test, such equipment is closely observed to determine that the temperature control devices are functioning properly to prevent the oil from attaining its autogenous ignition point.

Television Tubes. The large evacuated volume of television picture tubes makes them quite dangerous if improperly handled. The hazard involved is one of breakage, first resulting in an implosion, in which the glass particles of the envelope are forced inwards, and then followed by a rebound which causes the broken glass to be thrown outward. The size and velocity of the particles are such that serious injury can result. In the handling of picture tubes during the test work of television sets, special goggles are worn as a safety measure. The tubes are handled by the bulb only and are never carried with the neck used as a lever arm. When necessary to discard an old picture tube, the tube must not be broken by striking its face, sides, or neck, as this would result in an implosion. Instead, a small hole is first drilled axially through the center of the tube socket far enough to break the seal of the glass envelope located at the end of the tube neck. After atmospheric pressure has been restored, the tube can be broken or otherwise handled as any similar piece of glass.

Endurance Tests. Tests of a cycling nature are occasionally operated overnight to minimize the time required for completion of a specified number of cycles. When this is necessary, the test setup is carefully checked and given special care to reduce all possible fire hazards. Where possible, temperature-sensitive or time delay devices are incorporated to shut down the assembly in case trouble should occur. As a double check, at least two engineers review the test circuit and protection provided.

Education. It is very commendable to have a comprehensive set of safety rules established, but if these rules are not observed, they are no better than none at all. All personnel involved in test work at Underwriters' Laboratories are fully informed of the special safety equipment and precautions which have been made available. In addition, the ordinary safety practices generally recognized as being of prime importance are made familiar to all concerned. Each laboratory assistant is instructed regarding all details of a test to which he may be assigned and is informed of the hazards which may be involved. It may be said that where the potential hazards are fully recognized, a measure of safety has been accomplished.

CONCLUSION

ALTHOUGH IT IS POSSIBLE to take many precautionary safety measures through careful consideration of test facilities, working areas, and rules of operation, an electrical laboratory can never be completely free of hazard. In the final analysis, the accident rate will inevitably be a function of the good sense exercised by the workers.

NIKOLA TESLA

Pathfinder of the Electrical Age

K. M. SWEZEY

Most engineers associate the name Tesla with the "Tesla coil," so popular for high-voltage demonstrations in the school laboratory. Few, however, know this strange, lonely genius as the inventive giant who not only laid much of the groundwork for radio, induction heating, and gaseous-tube lighting, but also invented the induction motor and the whole polyphase system which is the foundation of the modern electric power industry.

NEXT MONTH, the American Institute of Electrical Engineers will dedicate its Fall General Meeting in Chicago, Ill., to the 100th Anniversary of the birth of Nikola Tesla—late Vice-President, Fellow, and Edison Medalist of the AIEE, strange and prolific genius—one of the greatest electrical inventors of all time.

This will be a memorial, long overdue, for the practical and prodigal dreamer who gave the world—besides basic discoveries in radio, electrotherapeutics, high-frequency induction heating, gaseous tube and fluorescent lighting, and wireless control of vessels and torpedoes—the foundations for its whole modern electric power industry.

Back in 1895, Tesla's revolutionary induction motor and polyphase system for the generation and transmission of electric energy made possible the first large-scale harnessing of Niagara Falls. Today, practically all the electricity in the world—more than 1,000 billion kwhr last year—is generated, transmitted, and turned back into mechanical power by means of Tesla's motor and system. As proof that the Tesla system is as vital to the future Atomic Age as it was in helping to create the present age of electric power, the new General Electric power station at West Milton, N. Y., pours the same kind of Tesla polyphase electricity into the same Niagara–Mohawk network as the Niagara (N. Y.) plant of 1895, which is still going strong.

The story of how Tesla's polyphase inventions—first demonstrated dramatically at Niagara—transformed an era of local electric lighting to the new age of electric light and power everywhere, and how this universal availability of electricity has in turn changed the life, industry, and economy of the world, is an epic of engineering that has yet to be completely told.

A BRUSHLESS MOTOR

IN 1877, Tesla, then 21, had begun to study engineering at the Polytechnic School in Gratz, Austria. A Gramme dynamo had just been received from Paris and Professor Poeschl was running it before the class as a motor. Noticing

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that the brushes sparked badly, Tesla wondered out loud whether a motor could not be designed *without* brushes. Poeschl exploded. Would this young marvel convert a steadily pulling force, like that of gravity, into a rotary effort? It was another impossible scheme!

But Tesla had more faith in his own instincts than in his teacher's knowledge, and for the next five years mentally designed and operated various types of d-c and a-c machines. In 1880, he transferred to the University of Prague and the following year he took a position with the newly formed telephone company in Budapest, Hungary.

One afternoon in 1882, the solution to his "impossible" motor flashed through his brain. Tesla saw clearly a brushless, commutatorless rotor spinning in an electric whirlwind, a rotating magnetic field produced by two alternating currents out of step with each other. Picking up a stick, Tesla drew diagrams on the sand—diagrams for the induction motor he was to present before the AIEE six years later.

Tesla came to New York in 1884 with four cents in his pocket, a headful of ideas for developing his brainchild, and a contract to redesign d-c motors for Thomas Edison. Completing this job, Tesla left Edison to work on his own. At first, finding no backing for his radical plans, he was forced to earn a living by digging ditches. By 1887, however, he had formed the Tesla Electric Company and had built models of his brushless motor which compared favorably with the best d-c machines of the day.

On May 1, 1888, Tesla was granted basic patents on his motor and on the associated method of transmitting power by polyphase currents. Two weeks later he delivered his classic lecture, "A New System of Alternate Current Motors and Transformers," before the AIEE.

When, in 1917, the AIEE presented the Edison Medal to Tesla for these inventions, Dr. B. A. Behrend commented on this lecture: "Not since the appearance of Faraday's 'Experimental Researches in Electricity' has a great experimental truth been voiced so simply and so clearly as this description of Mr. Tesla's discovery of the generation and utilization of polyphase alternating currents. He left nothing to be done by those who followed him. His paper contained the skeleton even of the mathematical theory."

WESTINGHOUSE BUYS TESLA'S PATENTS

Tesla's motor arrived at the height of the "battle of the currents and the systems." In 1888, there were operating in the United States several score of electrical "systems," each designed for a special use and usually named for a promoter or inventor. The fight between the advocates of direct current and alternating current was also under full sway.

Edison's low-voltage direct current had become popular for local lighting in big cities and was running a few small motors in printing plants and factories. Because direct current could not be transmitted economically more than about half a mile, however, d-c stations had to remain small and practically in a customer's backyard. Alternating current, however, could be generated in large bulk and transmitted many miles, but there was no practical a-c motor.

To George Westinghouse, who had founded the Westinghouse Electric Company two years before and already was America's foremost champion of alternating current, Tesla's motor seemed the missing key to a-c supremacy. By the end of July, Westinghouse had acquired rights to the polyphase patents and to Tesla's services.

The Tesla polyphase motor, however, proved to contain all the headaches and heartaches of an invention ahead of its time. In the first place, it was not an isolated device that would run by hitching it to an existing a-c line. It was part of a whole new method for the generation, transmission, and utilization of power. To sell the motor, Westinghouse would first have the job of selling Tesla's radical new system.

THE SPLIT-PHASE MOTOR

To help out in the meantime, Tesla invented the split-phase motor, an ingenious adaptation that made one phase do the work of two. Even this motor would not work well on the 133-cycle current then in use. After long and costly experimentation, Westinghouse engineers finally decided to change the central station frequency to suit the motor. The frequency settled on was 60 cycles, the one now standard for general use.

Westinghouse's big chance to introduce the polyphase system came in 1892 when he was awarded the contract to light the Chicago World's Fair of 1893. For this job he improvised twelve 1,000-hp 2-phase generators from twenty-four 500-hp single-phase generators (the largest then in existence) coupled in pairs. As an extra attraction, he exhibited the first complete polyphase system ever assembled. In this, current from a 2-phase generator was stepped up by a transformer, sent over a transmission line, stepped down again by transformers, used as 2-phase current to run induction and synchronous motors, and as single phase to light lamps and run split-phase motors. To show the complete adaptability of the system, a rotary converter changed polyphase alternating current into direct current for running a railway motor.

POLYPHASE SYSTEM HARNESSES NIAGARA

This exhibit so impressed the engineering and scientific advisers of the Niagara Falls Power Company, which had been trying for years to find a satisfactory means to harness 100,000 hp of Niagara's power, that—against the advice of such authorities as Edison and Lord Kelvin—they decided to adopt the Tesla system on the spot.

In 1895, the first two 5,000-hp Tesla-Westinghouse polyphase generators began turning at Niagara. In 1896, a 22-mile line erected by J. G. White and equipped with transformers and rotary converters by the General Electric Company, carried Niagara power to run street cars and operate lights in Buffalo.

The success of Niagara was immediate and contagious. Seven more 5,000-hp generators were ordered from Westinghouse to complete Power House No. 1, and the General Electric Company (which was permitted to use the Tesla patents by a cross-licensing arrangement made with Westinghouse in 1896) was given a contract to make 11 similar generators for Power House No. 2. By the time the plant had been completed in 1903, practically all other big generating stations in the United States either had adopted the Tesla system or were about to change to it.

Fig. 1. Nikola Tesla, in his sixties, is shown adjusting a radio device in his New York laboratory. The picture on the wall is of an electromechanical oscillator which was built by Tesla in the 1890's.

FIRST PLANT FOR INDUSTRIAL POWER

Before Niagara, electric plants were designed primarily for lighting; the use of electricity for motors and heating was incidental. The Niagara plant was the first big station in the world planned primarily to deliver industrial power. Besides taking the place of steam engines in factories, this new power, provided in previously unheard-of quantities, made possible the commercial electric furnace and inaugurated a giant electrochemical industry.

The first customer of Niagara power was the Pittsburgh Reduction Company, now the Aluminum Company of America. Cheap Niagara power helped turn this now indispensable metal from an expensive novelty into a commercial success. With an electric furnace operated by a steam-driven generator, Dr. E. G. Acheson had made a commercial failure of carborundum. As Niagara's second customer, he was enabled to found a giant artificial abrasives industry. Calcium carbide for acetylene; calcium cyanamide for nitric acid, explosives, and fertilizer; artificial graphite for motor brushes, furnace electrodes, battery carbons, lubrication; ferrosilicon, ferrochromium, ferrotitanium, for machinery, dies, armor; chlorine, phosphorus, caustics, ammonia, and so on—all these were born with the aid of Niagara power or made more cheaply because of it.

POLYPHASE PATENTS PROVED INVULNERABLE

Like all successful inventions, the polyphase system and motor became involved in long and costly litigation. The biggest companies and the best brains in electrical engineering took sides in defending and fighting a series of inventions which covered all generation and use of polyphase power in the United States. To the astonishment and dismay of engineers who had regarded Tesla as an impractical genius, the polyphase patents turned out to be not only the most fundamental but also the most concrete patents in the industry. They were never broken. Originally nearly sending the Westinghouse Electric Company into bankruptcy, these patents soon became the foundation for its later greatness.

NEW FIELDS TO CONQUER

With characteristic indifference to the commercial development of his ideas, Tesla left his polyphase system for others to introduce and plunged on to new frontiers of science. Before the turn of the century, he had made substantial contributions to practically every branch of electricity.

Several years before the very first experiments of Marconi, Tesla developed high-frequency alternators and his famous "Tesla coil" for producing high voltages, a device which remains today in one form or other in every radio and television set. He then went on to invent and build rotary and series spark gaps, oil-insulated transformers and capacitors, mica capacitors impregnated with wax under a vacuum, stranded conductors of separately insulated wires (later called "Litzendraht"), arcs for producing continuous waves, choke coils, apparatus for selective tuning by means of a complex of several waves, and a "ticker" for receiving continuous waves.

Before 1897, Tesla had developed a number of wirelessly controlled mechanisms, and in that year built several boats that were started, stopped, steered, and otherwise operated by radio. He demonstrated these widely in New York in 1898, and before the Commercial Club in Chicago in 1899. This work, with what Tesla called "telautomatics," was the beginning of the concept which has led to today's array of wirelessly guided weapons.

WIRELESS LIGHTS AND RADIO BROADCASTING

During the early 1890's, Tesla devised all kinds of wirelessly lit vacuum and gas-filled tubes. He increased the brilliance of some by using uranium glass or coating them with phosphors, thus creating pioneer fluorescent tubes. He bent many to suit the requirements of the room they were to light, and others to form words or names, as in modern display lighting. Tesla displayed some of his neon-type tubes in his personal exhibit at the 1893 World's Fair.

Among other achievements, he devised a turbine with smooth parallel blades and synchronous electric clocks which he hoped some day to power as well as synchronize by radio. He also attempted to transmit power wirelessly by disturbing the electrical charge of the earth. Before Marconi had flashed his famous "S" across the Atlantic, Tesla talked of a "World Wireless" system which not only would send messages, but also would connect all the telephone exchanges and stock tickers on the globe, send facsimiles of photos, checks, and records, and inaugurate a system of world printing. At the turn of the century, he gave a detailed description of the radio broadcasting that blossomed forth several decades later.

Fig. 2. Interior of Power House No. 1 of the Niagara Falls Power Company, at the turn of the century, the electrical wonder of the world. Installed in the years 1895-99, the ten 5,000-hp generators shown here are still in operation.

INSPIRATION TO OTHER PIONEERS

BESIDES HIS PERSONAL ACCOMPLISHMENTS and the countless fertile ideas which he scattered for others to harvest, Tesla's lectures and writings inspired many others into the new fields of radio and electrical engineering.

While a student at Yale, Dr. Lee De Forest began reading Tesla's writings. He wrote in his diary: "His (Tesla's) works are the greatest exciters to zealous work and study . . . To read those chapters on the higher vibratory forms, the intimate connection between light energy and electricity . . . fires me with ambition to emulate . . . It would make a genius of any man whose soul is not of clay." In his autobiography, De Forest states further that this inspiration gave him the first clear intimation of the fascinating field of research that was later to frame his life.

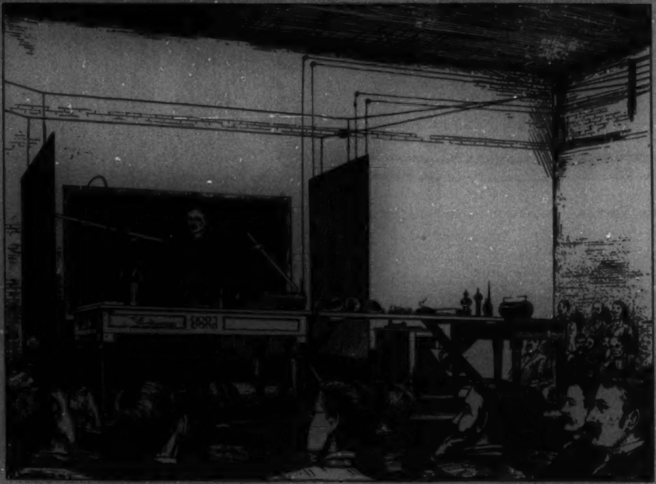
Gano Dunn assisted Tesla at his historic lecture before the AIEE at Columbia University, May 20, 1891, "Experiments with Alternate Currents of Very High Frequency and Their Application to Methods of Artificial Illumination." Attendance at this lecture included a veritable "Who's Who" of electrical pioneers: Prof. W. A. Anthony, H. Ward Leonard, E. W. Rice, Jr., Frank J. Sprague, William Stanley, Elihu Thomson, Edward Weston, Schuyler S. Wheeler, J. G. White, E. A. Sperry, and Prof. George Forbes. This contact, wrote Dunn to Tesla 40 years later, "left an indelible impression and an inspiration which has influenced my life."

Dr. Robert Millikan, Prof. John B. Whitehead, Major Edwin Armstrong, Dr. E. F. Northrup, Count von Arco, Andre Blondel, Jonathan Zenneck, D. McFarlan Moore, Charles F. Scott, are among others who have publicly acknowledged a similar debt.

Thomas C. Martin's book, "Inventions, Researches and Writings of Nikola Tesla," published in 1894, was often the main source of stimulation. Of this, Armstrong wrote at the time of Tesla's death in 1943, ". . . one can imagine the inspirational effect of the book forty years ago on a boy about to study the electrical art. Its effects were profound and decisive." In 1894, Moore—who later developed one of the earliest practical tube lights, the Moore Light—told T. C. Martin that this book would still be a classic a hundred years hence.

In 1931, when Tesla was turning 75, it was my privilege to collect letters of birthday greetings from pioneers in radio and electrical engineering from all over the world. Dr. B. A. Behrend and Prof. Charles F. Scott were cosponsors of this little gesture of affection and esteem, and 14 past presidents and more than 50 members of the AIEE took part.

Many of the letters gave further evidence of the role of Tesla's brilliant pioneering efforts in inspiring the later practical developments of others. Dr. Northrup told how, as a boy in 1893, he was thrilled by a Tesla demonstration at the Franklin Institute, and how in 1916, when he was searching for a new method for melting metal electrically, he had turned back to Tesla's ideas. Using these ideas,



Reprinted from Electrical World, July 11, 1891

Fig. 3. Nikola Tesla lecturing before the AIEE at Columbia University, May 20, 1891.

Northrup developed his high-frequency induction furnace.

Prof. André Blondel wrote from Paris: "In 1892 I had the pleasure of assisting at the public demonstration you gave to the Société Francaise des Electriciens which united about you all the notables of French science and electrical engineering . . . From this demonstration and from your remarkable publications preceding it there was born the development of high frequency currents in various fields and particularly the medical field thanks to the beautiful researches of Prof. d'Arsonval."

John Hays Hammond, Jr., while still a student at Yale, knew Tesla and was inspired by Tesla's wirelessly controlled boat. Later, Hammond established a research organization in which he spent more than 20 years creating and developing radio-controlled devices for ships, airplanes, and missiles—many of which are incorporated in guided missiles of today. Hammond spoke of Tesla as "the poet of science of our generation."

SHARED FAME WITH EDISON

At the turn of the century, Tesla and Edison were, without doubt, the most famous electrical men in the world. Of the two, opinion was sharply divided as to which was the greater. In 1894, in the *New York World*, Arthur Brisbane wrote about Tesla's "wonderful discoveries" under the headlines: "Our Foremost Electrician—Greater Even than Edison." In 1895, Charles A. Dana wrote editorially in the *Sun:* "It is not in any degree an exaggeration to say that the men living at this time who are more important to the human race than this young gentleman can be counted on the fingers of one hand; perhaps on the *thumb* of one hand."

Tesla's personal lecture-demonstrations—which he gave before the AIEE, the Franklin Institute, the National Electric Light Association, the Royal Institution, the Institution of Electrical Engineers in London, and so on—were world renowned. After his lectures in England and France, in 1892, the *Electrical World* spoke of "the laurels still fresh that were accorded him by the savants abroad, the equal of which have been accorded to no one before while living." His lecture before the National Electric Light Association in St. Louis, in 1893, had to be moved from the regular meeting place of the association to the Grand Music Hall, seating 5,000. Complimentary tickets were sold at $4 and $5 each; 4,000 programs, containing biographical sketches of Tesla, were sold on the streets.

In Europe, Tesla's fame has never diminished. Celebrations of Tesla anniversaries have been held in England, France, Germany, Austria, and Yugoslavia. Several books about his achievements have been published in German. Yugoslavia, the land of his birth, has established a Tesla Institute for scientific research and a Tesla Museum in which is housed all his personal papers and other belongings.

After Tesla's death, the British Institution of Electrical Engineers arranged a memorial lecture at which Dr. A. P. M. Fleming recreated some of Tesla's classic demonstrations. At the end, Dr. W. H. Eccles, himself a noted engineering pioneer, said he "had been driven to the conclusion that Tesla was the greatest electrical inventor we have had on our role of membership; in fact we might go so far as to say that he was the greatest inventor in the realm of electrical engineering."

Commemorations by the AIEE, the Institute of Radio Engineers, universities, the press, radio, and television are this year expressing some of the gratitude and esteem of America, the country Tesla officially adopted in 1891 and in which he lived to do all his great work.

Dr. E. F. W. Alexanderson, one of the most noted pioneers in electric power engineering still with us, wrote me a year ago: "We think of Tesla's contribution much oftener than that of Ampere and Ohm, although their names have become part of the language . . . the induction motor and our power system are enduring monuments to Nikola Tesla."

As this is being written, word comes that Tesla's name has just been added to those of Ohm and Ampere. At its meeting in Munich, June 29–July 7, the International Electrotechnical Commission agreed formally to adopt the name "Tesla" for the unit of magnetic flux density in the MKS or Giorgi system.

Minimum-Cost Loading of Transformers

ARTHUR KLOPFENSTEIN
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A POWER TRANSFORMER can be loaded for minimum cost per kva. Costs to be considered are the capital costs of interest, insurance, and taxes, as well as the operating costs of depreciation, losses, and maintenance. All these costs can be related to loading if an adjusted transformer rating is used. This adjusted rating is the peak load to be allowed before additional capacity is provided.

Table I. Coastal Residential Load (Assumed Data)

Winter load cycle	60 per cent±40 per cent
Summer load cycle	30 per cent±20 per cent
Winter ambient	13 C±7 C
Summer ambient	24 C±7 C
Growth cycle	3 years
Growth rate	Doubles in 10 years

Table II. Irrigation Pumping Load (Assumed Data)

Summer load cycle	90 per cent±10 per cent
Winter load cycle	10 per cent±5 per cent
Summer ambient	26 C±14 C
Winter ambient	7 C±6 C
Growth cycle used	3 years
Growth rate	Doubles in 10 years

Depreciation costs used in this study were based on lives computed from theoretical deterioration of insulation caused by heat. A conservative aging curve[1] was used for computation. Computation of the cost of losses was simplified by use of a continuous equivalent load, which would cause the same rate of aging as the cyclic loads studied. Maintenance cost was neglected, since maintenance on transformers does not seem to be related to load.

Two extremes of thermal conditions are studied to demonstrate minimum-cost loading. A rapid depreciation seemed to be possible with an interior valley irrigation pumping load having a summer daytime peak, high load factor, rapid growth, and high ambient. A less rapid depreciation occurs with a coastal residential load having a winter evening peak, no load factor, rapid load growth, and medium ambient. See Tables I and II.

An equation to compute aging,[2] and a curve for predicting insulation aging,[1] are used. Recent aging prediction curves are more optimistic. These would allow minimum-cost loading, with higher peak loads than computed in this study.

Most transformers now in service are relatively new, and correlation between laboratory predictions of failures and actual service failures may come after many years of data collection. Use of laboratory predictions seem better than guessing in the meantime.

Results of typical cost studies are tabulated in Tables III and IV. A high exponential increase of predicted depreciation costs by allowing higher peak loads is compared with a linear increase in savings obtained with increased peak loads.

Use of laboratory aging predictions are recommended for computing depreciation and determining a minimum-cost load practice.

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Table III. Computed Cost Per Power Transformer Kva for Residential Load

Ultimate Peak Loading, Per Cent	Adjusted First Cost, Dollars	Annual Fixed Cost, Dollars	Computed Life, Years	Straight-Line Depreciation, Dollars	Average Interest, 3 Per Cent, Dollars	Annual In and Out, Dollars	Annual Loss, Dollars	Total Annual Cost, Dollars
100	4.00	0.24	190(50)	0.02(0.08)	0.12	0.00	0.01	0.39(0.45)
110	3.60	0.22	122(50)	0.03(0.07)	0.10	0.00	0.03	0.38(0.42)
120	3.30	0.20	75(50)	0.04(0.06)	0.10	0.00	0.05	0.39(0.41)
130	3.10	0.19	40	0.08	0.09	0.00	0.07	0.43
140	2.90	0.17	22	0.13	0.09	0.01	0.09	0.49
150	2.70	0.16	8.9	0.30	0.08	0.02	0.12	0.68

Table IV. Computed Cost Per Power Transformer Kva for Irrigation Pumping Load

Ultimate Peak Loading, Per Cent	Adjusted First Cost, Dollars	Annual Fixed Cost, Dollars	Computed Life, Years	Straight-Line Depreciation, Dollars	Average Interest, 3 Per Cent, Dollars	Annual In and Out, Dollars	Annual Loss, Dollars	Total Annual Cost, Dollars
80	5.00	0.30	200(50)	0.02(0.10)	0.15	0.00	0.05	0.58(0.66)
90	4.40	0.26	100(50)	0.04(0.09)	0.13	0.00	0.06	0.49(0.65)
100	4.00	0.24	44	0.09	0.12	0.00	0.08	0.53
110	3.60	0.22	23	0.16	0.11	0.01	0.10	0.60
120	3.30	0.20	12	0.27	0.10	0.02	0.12	0.71
130	3.10	0.19	5.5	0.56	0.09	0.03	0.14	1.01
140	2.90	0.17	2.4	1.10	0.09	0.05	0.16	1.57
150	2.70	0.16	0.75	3.60	0.08	0.06	0.20	4.20

NOTE: Parentheses assumes 50-year maximum practical life.

Digest of paper **56-628**, "Minimum-Cost Loading of Transformers," recommended by the AIEE Committee on Transmission and Distribution and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in the AIEE *Power Apparatus and Systems*, 1956.

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Adapting a Trolley Coach System to a Changing Traffic Pattern

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Population growth and increased private motor vehicle ownership have created considerable congestion in most American cities. Efforts made to help relieve this situation in Seattle by adapting the existing trolley system to meet the new traffic problems are described.

THE PAST 16-YEAR PERIOD has been one of tremendous growth and progress in a number of our American cities. To illustrate this growth and the accompanying transportation problems, the City of Seattle, Wash., will be used as a typical example.

The great influx of manpower brought about by the war increased the population within the immediate city limits from 368,000 in 1940 to the present 555,000; added to this is 150,000 overflow in the suburban area. The population growth, coupled with 120 per cent increase in private motor vehicle ownership in the same period and the peculiarities of the geography of the city, created unbearable traffic conditions for both private and public transportation. To speed up traffic flow, extensive research and planning led to street widenings, underpasses, viaducts, and traffic engineering programs in an effort to relieve the ever-increasing traffic congestion problem.

In the year 1940, an enabling act by the State Legislature made the modernization of an antiquated street railway system possible. Public preference for trolley coaches had been established. A temporary one-mile demonstration trolley coach line was installed and operated in the metropolitan area. Prior to this, a study had been made contemplating the abandonment of all rail operation and substituting therefor trolley coaches, supplemented by motor coaches. Fixed trunk routes on 100 street miles of the city area were established.

Since the conversion to the modern electrically propelled vehicle, the recommendation made to the Transit Commission in the 1939 report has been fully justified, both to management of the Seattle Transit System, and to the riding public (Fig. 1). Public preference for the trackless trolley has been developed by a record of consistently dependable service, riding comfort and fast acceleration. Management has been aware of its low operating cost and the greater life expectancy of the coach. Despite Seattle's predominantly hilly terrain and the overloaded riding conditions during the war period, and the ever-increasing traffic congestion problem created by the 33½ per cent population increase, the trolley coach fleet of 307 vehicles has proved its dependability in performance and economy of operation.

CONVERSION TO ONE-WAY STREET GRID

THROUGHOUT THIS PERIOD of rapid migration of people to the city with the ensuing steps aimed at solving congestion, the trolley coach proved conclusively its adaptability to the demands of changing traffic conditions and street construction programs. Changes in a traffic pattern have a direct influence on public transportation. In each instance where a change has been necessary to the trolley overhead and its electrical distribution system, advantage was taken of the opportunity to rehabilitate and improve existing overhead facilities in both design and material.

The finest example of the adaptability to major changes was evidenced in the conversion of trolley coach overhead in the one-way street program. While preliminary surveys and studies were being made by the City Engineering Department in close co-operation with Transit management and its Engineering Department, the various Transit departments concerned with the changeover were submitting their requirements in planning the conversion. The design of the feeder distribution system was carefully planned. Cable capacities were increased where practical for present and future demand. In the overhead system, high-speed curves were designed and trolley tracks were relocated to provide greater operational speed and flexibility. The new design (Fig. 2) called for the maximum simplification of overhead assemblies throughout, aimed at improving service and decreasing future maintenance costs. Experience had shown that these changes could be effected with ease and dispatch without addition of manpower to the existing personnel of the overhead department.

About the middle of September 1954, a final plan was evolved and an estimated cost submitted. Shortly prior to this, an ordinance was passed by the City Council changing all but two of the main thoroughfares to one-way operation. On September 26, 1955, all the emergency turnouts and parade loops which would not hamper regular service were removed to provide material for the beginning of the conversion. No provision was made to convert back to the old operation, as it was felt that if the one-way program proved inefficient, changes could be taken in stride, even to the extent of restoring the overhead to its original operation. Construction schedules were established by areas to insure the meeting of changeover deadline. The deadline dates were fixed after conferences between the City's traffic

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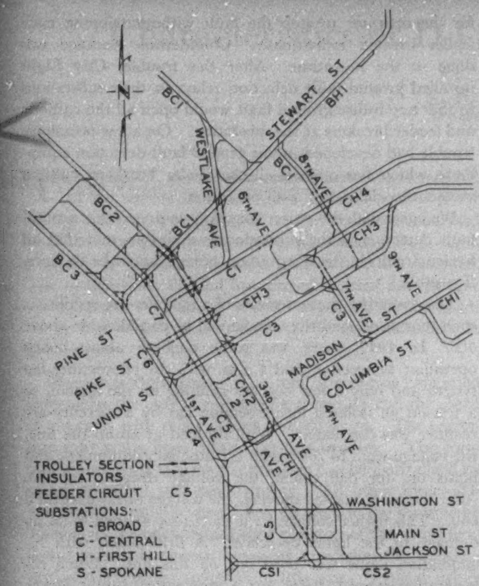
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SUBSTATIONS:
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C - CENTRAL
H - FIRST HILL
S - SPOKANE
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MAIN ST
JACKSON ST
C5
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CS2

Fig. 1. Metropolitan area trolley coach overhead prior to one-way conversion.

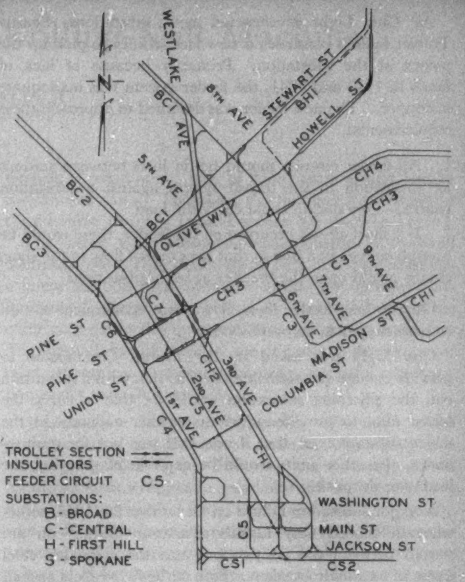
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Fig. 2. Metropolitan area trolley coach overhead for one-way operation.

engineers and those departments of the Seattle Transit System involved with the changeover. The actual new construction, with the exception of setting of steel and wood poles and building eyebolts, started on October 19. The work progressed through a period of severe winter weather and the added traffic congestion caused by the holiday shopping rush. However, on January 15, 1956, the last deadline was successfully met and the major portion of construction completed.

In this 4-month period, the regular maintenance line crews installed 60 building eyebolts, removed 28 and reset 19 steel poles, set 21 wood poles with their related cross-arms and guys, and installed 5,660 feet of aerial and underground feeder cable. In conjunction with the removal of 6.19 miles in the installation of 3.24 miles of 2/0 trolley-wire track, a total of 463 curve segments, crossover, trailing and turnout assemblies were removed or installed at the intersections. The conversion resulted in a removal of almost 6 miles of trolley wire and a reduction of 19 overhead assemblies. The completed installation is characterized by 23-degree wye-type turnouts which fan out into double tracks for either turning or straight-through operation (Fig. 3), and an increased use of low-degree curve segments to effect sweeping turns and passing tracks, allowing independent coach loading at bus zones, and improved local and express service. The net result of this new trolley overhead system in Seattle's metropolitan area will be the savings in operating and maintenance costs.

600-VOLT SUPPLY AND FEEDER DISTRIBUTION SYSTEM

The story of progress and adaptability to change could not be told without the co-operation displayed throughout by the Lighting Department, Seattle City Light. The role which it has played in the development of this trolley coach system is an ideal example of the attitude of a power company toward the traction load. Since 1940, the electrical operation of the Seattle Transit System has represented an important part of City Light's business, and from the outset, it has realized the desirability and potential of this load. The transit system load is desirable chiefly because of the size of the load and its utilization of equipment, and the fact that a transit peak load is developed before and after the general industrial load.

City Light owns and operates the d-c substations; in 1945, there were a total of 13 of these stations. Seven were motor generators, one a synchronous converter, and five were mercury-arc rectifiers. From 1945 until the end of 1954, City Light carried out a program of replacing the old stations with new rectifier substations. In all, 12 new rectifier stations were built, and 2 old rectifier substations were modernized, giving 14 in the new pattern with a total capacity of 21,200 kw.

The purpose of City Light in changing all the manually operated substations over to automatic mercury-arc stations primarily was to save manpower, hence reduce costs. Two of the new substations are located at a-c switching stations and are attended, but not for d-c operation.

As City Light constructed new substations, Seattle Transit System constructed new feeder lines to pick up the power at the substation. Primarily because of lack of funds in 1940 and 1941, the feeder system was inadequate in copper. The new feeder was designed to approach these requirements:

1. All feeder circuits should be tie lines between stations for protection to the transit system against a substation failure. One station could carry the load.
2. If a short circuit occurred on the feeder, there would be enough copper in a line so that the current flow to the short circuit would open the breaker at both substations.

On the long feeder lines, it was not economical to add enough copper to accomplish this.

City Light was asked by the Transit Commission to provide enough substation capacity so that with a substation out, the adjoining substation would be able to carry the load; also, to provide sufficient rectifier capacity in the major substations so that if one unit was out for maintenance, the other units would be capable of carrying the load over the peak.

A major substation failure on December 26, 1946, somewhat influenced City Light's substation design—an arc started between the positive bus and the grounded steel frame of a cathode breaker. Both cathode breakers and all the tie feeder breakers fed into the arc. It was impossible for the operator to stop the fault without tripping each feeder breaker individually. Considerable damage was done in the meantime. After this trouble, City Light installed ground fault detection relays in their substations so that any future ground fault would open all the cathode and feeder breakers at the substation. On a few occasions, trouble had developed in this ground fault detection equipment which has opened all the feeder breakers, causing momentary delay to transit operation.

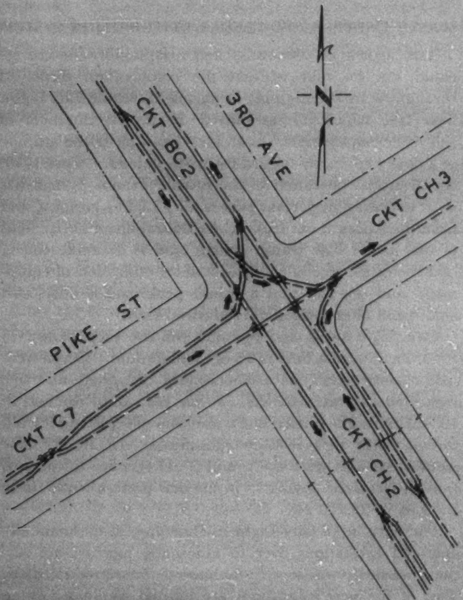

Fig. 3. Typical one-way street trolley coach overhead intersection.

We agree with the power company engineers that ground fault detection at the substations is desirable, and that all feeder circuits in the distribution system should be tie lines, if possible.

The operating characteristics of a mercury-arc rectifier is such that at no load the voltage will be considerable above 600. In 1949, there was some concern about coach operation between 2 and 4 a.m. with an all rectifier-fed system and only a few coaches running on the system, so a test on an isolated feeder section fed by a mercury-arc rectifier was conducted. With no load at all on the line, the voltage went to 780; with the auxiliary equipment and lights on, for one coach, the voltage dropped to 680. After the coach started moving, the voltage rarely exceeded 660. This higher voltage for a short time seemed to do no damage to the lights or relays. A Brill coach with regeneration alone was tried out on this line. When regeneration started, there was a momentary bright flicker of the lights and the coach line breaker opened, then the line breaker reclosed and the operator applied power to keep the coach moving. These tests demonstrated that an all rectifier-fed system could be operated even if there were only one coach.

In some of the later substations, City Light has installed "rate of rise" relays on the feeder breakers. These relays are sensitive to a sudden rise in current caused by a short circuit on the line. On long feeder lines of which there is not sufficient copper so that a short circuit on the remote end will open the overload current relay, the "rate of rise" relay will open the breaker and protect the line.

CONCLUSION

Progress and expansion are both expected and accepted. It is a standard by which this country has grown from the beginning. As engineers, we cannot subscribe to practices that embrace stagnation, our purpose being to comprehend new engineering developments and apply the principles to meet the needs of a modern transit operation. Transit engineers can be sure of having to plan major revisions to their systems to meet new traffic problems as they arise. The trolley coach has established a firm position in the business of moving people. Advantage must be taken of every advanced design of both the distribution system and vehicle. The future holds many bright prospects for the electrically propelled vehicle. Already there is talk of automation in the transit field. The transit and power-company engineers must be ready for a changeover when it comes. The electrically propelled vehicle is the logical choice in the development of mass transportation and the power companies of the nation hold the key to its future.

Characteristics of D-C Rolling-Mill Machines

E. P. SMITH
MEMBER AIEE

TRANSIENT, as well as the steady-state characteristics, of d-c motors and generators must be known if the rolling-mill system performance is to be thoroughly analyzed and the operating performance predicted. This digest presents the transient characteristics of the d-c machine. The constants are divided into three phases of d-c machine performance: (1) direct- or main-axis field, (2) the quadrature axis or interpolar axis, and (3) the mechanical or speed axis.

Direct-Axis Performance. The total direct-axis excitation determines the output voltage of a generator and the speed of a motor, with other factors held constant. The excitation may come from more than one winding. The compounding effects of armature reaction can be neutralized by using the offset pole-face winding. All other direct-axis windings are usually very closely coupled to the shunt field. Therefore, the open-circuit time constant of the shunt field is the principal constant necessary to predict the transient performance of the machine in this axis. Typical values of this constant are shown in Table I.

These time constants are based upon the air-gap line of the machine, i.e., the unsaturated value. An equation has been developed to show the effect of design parameters on this constant.

The effect of eddy currents can no longer be neglected or approximated by a simple experience factor because of the fast response required by modern systems. A good representation of the direct axis under transient operation is obtained by calculating the constants[1] defining the eddy-current effects.

Quadrature-Axis Performance. The armature circuit time constant T_i represents this axis. The inductance may be determined from design data[2] or approximated from machine rating.[3] The magnitude closely fixed by machine rating, thus can be varied only a small amount economically.

Armature-circuit resistance can be varied over a considerable range without appreciably affecting the inductance value. The per-unit magnitude of this resistance depends upon the base speed, speed range, maximum overload, voltage rating, temperature rise, regulation, effectiveness of ventilation, type of compensation, and length-to-diameter ratio. Therefore, this parameter varies over a considerable range. Typical values are given in Table I.

The other quadrature-axis characteristic is transient commutation. The commutating field flux must maintain a linear relation with armature current for optimum performance. The flux lags behind the current because of the eddy currents in the magnetic structure during transients. The method[1] can be used by the designer to determine the most economical method of obtaining successful commutation under transient loads.

Mechanical- or Speed-Axis Performance. The third axis of performance of the d-c motor evaluates the ability of a motor to develop torque from the stored energy in the rotational mass with loss in speed and the dissipation factor connected therewith. This time constant is: $t_s = 2Hr_a$, where H is the inertia constant,[4] and r_a is the per-unit resistance of the armature circuit. Table I gives typical values of H for modern design motors of two-to-one speed range. The connected load inertia must be included for system calculations.

In conclusions, the d-c machine has three principal parameters that describe its transient behavior. The values of these constants vary over a wide range with respect to rating. A secondary set of parameters is required to define the transient characteristics because of eddy currents in the magnetic structure. The tabulated constants permit the system engineer to make preliminary studies without design data.

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3. Rate of Rise of Short Circuit Current of D-C Motors and Generators, A. G. Darling, T. M. Linville. AIEE *Transactions*, vol. 71, pt. III, 1952, pp. 314–25.

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Table I. Direct-Axis Performance

Class of Machine	Shunt-Field Time Constant, T_{f0}, (Unsaturated), Seconds	Constants: Armature-Circuit Resistance (75 C),* r_a, Per Unit	Constants: Armature-Circuit Time Constant t_i, Seconds	Inertia Constant,† H_0, Base Speed, Seconds
Generators				
Synchronous motor-generator sets, 40 C, open	2.0– 4.0	0.02 –0.03	0.02 –0.025	—
Motors				
Standard, 40 C, open	3.5– 7.0	0.025–0.06	0.02 –0.04	0.30–1.00
Rod mill, 40 C, open	3.0– 6.0	0.02 –0.05	0.03 –0.07	0.30–1.20
Standard, 40 C, forced ventilated	3.0– 6.0	0.03 –0.07	0.03 –0.07	0.35–0.60
Low inertia, 40 C, forced ventilated	3.0– 7.0	0.035–0.07	0.03 –0.05	0.20–0.40
Reversing mill, 50 C, forced ventilated	5.0–10.0	0.035–0.08	0.03 –0.05	0.15–0.30
Low inertia, 60 C, forced ventilated	3.5– 6.0	0.05 –0.09	0.025–0.04	0.10–0.20

NOTE: * Includes 3-volts brush drop. † Motor rotor only at base speed.

Digest of paper 56-639, "Transient Characteristics of D-C Metal Rolling-Mill Motors and Generators," recommended by the AIEE Committee on Mining and Metal Industry and approved by the AIEE Committee on Technical Operations for presentation at the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956. Scheduled for publication in AIEE *Applications and Industry*, 1956.

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Beginnings of Switching Theory in the United States

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A brief history of the development of telephone switching in the United States, starting from 21 to the present-day 60 million telephone subscribers, is presented. Application of traffic probability theory was first applied in the telephone traffic engineering field, as described.

TELEPHONE switching began with the opening of the first commercial telephone exchange in New Haven, Conn., on January 28, 1878. Twenty-one subscribers on eight lines shared this history-making event with the New Haven District Telephone Company.

Unfortunately, no records exist and none of the designers of that famous board, shown in Fig. 1, are still alive to tell the reason why exactly two interconnecting paths—or intraoffice trunks as they would now be called—were provided for the switching accommodation of the customers. Perhaps the designers believed that one trunk would satisfy all practical needs, but that in a new untried system an additional "spare for maintenance" was justified—or that with 2 trunks, they could advertise that a multiplicity of conversations might be held simultaneously. At any rate the choice was doubtless made by what is called "judgment," an important method of making decisions not unknown today among traffic engineers.

The problem of growth must almost immediately have taxed the estimating powers of the "traffic manager," since the New Haven telephone directory of February 21, 1878, less than a month after opening day, showed the subscribers had grown from the initial 21 to a total of 50. (They comprised 11 residences, three physicians, and two dentists; 20 stores and factories; four meat and fish markets; two hack stables; and eight labelled "miscellaneous," including two printing offices, police, post office, and two men's clubs.)

It was soon observed that, although two "trunks" may have been barely adequate to care for eight lines, when another length of board was added, surprisingly enough, the total of four trunks was more than sufficient to serve 16 lines. At that point was born the trunking philosophy, which underlies much of the theory and practice that the inheritors of the art endeavor to apply to today's vastly complex switching arrangements. In the following, some of the halting early steps will be described by which the theory of probability came to play a central part in the design, engineering, and operation of the telephone systems in America.

THE RAPID GROWTH OF TELEPHONY, 1880–1900

DURING THE YEARS immediately following the offering of commercial telephone service, exchanges and number of subscribers grew apace. Many small companies were formed and licensed under Bell System patents in order to operate in their local areas.

Occasionally, the competition increased to the point that subscribers were subjected to the inconvenience of finding two companies operating in the same town or city, necessitating the rental of a telephone from each if they wished to have access to the entire community. This overlap must have considerably complicated the traffic engineer's problems; its elimination comprises one of the few simplifications operating traffic men now enjoy, compared with 50 years ago.

By careful observation of average call rates per subscriber, plus the corresponding maximum numbers of conversations seen simultaneously on switchboards, the operating telephone companies gradually drew up tables and curves for guidance in new and expanded installations. Information of this sort was exchanged among the companies and collected by the engineering department of the parent American Bell Telephone Company, later the American Telephone and Telegraph Company (AT and T), for study and design purposes.

FIRST TRAFFIC ENGINEERING PRACTICES

THE FIRST "comprehensive" traffic engineering practices appeared in October 1903. They comprised a dozen curves and about 30 typewritten pages written by the engineering department of the AT and T Company; they were modestly called "Notes on Traffic Studies." They undertook "to outline the methods to be followed in general in preparing a traffic study on which to base the plans for a central office equipment . . . In order that the first installation and ultimate equipment may be determined, the study necessarily covers the past and present conditions, conditions at the end of an initial period, and those for the ultimate. The first installation is planned to accommodate the growth for $3^1/_2$ years from the date of study, that is, about 3 years from the time the board is placed in service. The ultimate plans are based on the estimated conditions at a date from 15 to 20 years later than the present."

Included in the Traffic Notes of 1903 are advices on measuring traffic by plug counts, the needs for predicting population expansion, and the necessity of developing sound estimates of future rates of calling.

Revised text of a paper presented before the First International Congress on the Application of the Theory of Probability in Telephone Engineering and Administration, Copenhagen, Denmark, June 20, 1955.

R. I. Wilkinson is with Bell Telephone Laboratories, New York, N. Y.

Fig. 1. First telephone switchboard installed in New Haven, Conn., providing for eight subscriber lines, 1878.

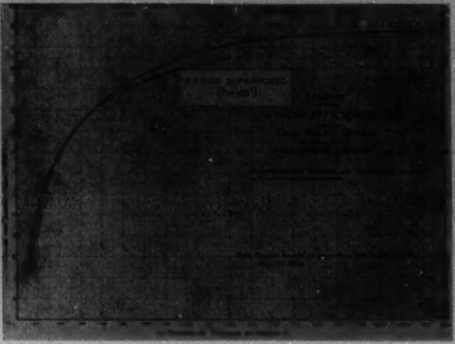

Fig. 2. Efficiencies of interlocal trunks for relay offices in 1902, "No Delay Basis."

One of the traffic engineering curves presented in these Notes is reproduced as Fig. 2. It shows objective efficiencies for interoffice trunks with call circuit operation expressed as allowable calls per trunk in the busy hour for a given number of trunks. If ringdown trunks were employed, only 75 per cent of the values shown were to be used. Although it was appreciated that call seconds and not calls should govern the group size, apparently the refinement of measuring holding times in each office was not yet justified and some general average was considered as applying well enough on local calls whatever the office or city.

It is interesting to see how well, by empirical means, the traffic engineers had generated a theoretical "probability curve." Assuming an average holding time of 165 seconds, the dotted curve drawn on Fig. 2 is for a Poisson probability of all paths busy of $P = 0.02$.

The toll trunk engineering curves dated October 1902 in the same Traffic Notes are reproduced in Fig. 3. The effect of considering total call minutes as well as numbers of calls is clearly evident—doubtless emphasized by the large cost of pole lines between cities. Some allowance is made for the greater efficiency of larger circuit groups, although of course this is not so evident when operating on a strong delay basis. The number of trunks was specified according to call minutes of traffic offered, regardless of the holding times involved.*

As shown near the top of Fig. 3, the curves are based on "statistics of L. D. [long-distance] business in N. Y. and Philadelphia in 19-- which gave the following equation for relation between the 'Busy Hour' (Y) and four times the maximum 15 minute period (X): $X = 1.14Y + 8.6$." Here was mathematical recognition, albeit empirical, of the relation existing between average load over a long period and the peak load expected in a shorter interval within the period.

MODELS OF TRAFFIC FLUCTUATIONS

It was natural that telephone men faced with the problems of administering the plant and large forces of operators to accommodate the oftentimes perverse fluctuations in traffic should be dissatisfied with empirically determined relationships between average busy-hour loads and those which might be expected in short intervals during the hour. E. C. Molina[1] has reported that "G. T. Blood of the A.T. & T. Company in 1898 found a close agreement between the terms of a binomial expansion and the results of observations on the distribution of busy calls." This seems to be the first comparison made in the United States of probability expressions with actual data on traffic phenomena. No records of Blood's studies are available, however, so the extent of his work cannot be judged.

A short time later, M. C. Rorty, then with the traffic department of the American Bell Telephone Company in Boston, Mass., became interested in the possibility of describing call fluctuations by means of probability theory. Rorty was a man of great energy and imagination and his numerous papers and memoranda are a pleasant combination of philosophy, economics, and practical engineering. He later had a distinguished business and professional career in the AT and T Company and the International Telephone and Telegraph Company. He was also president of the American Statistical Association, chairman of the board of the National Bureau of Economic Research, and at the time of his death in 1936 was president of the American Management Association.

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*It is perhaps of interest that the loadings recommended and the "approx. long distance average 1902" trunk use per call of 16 minutes, would produce T-8 to T-15 service, according to present methods of estimating speed of service, as shown in the following table:

Number of Trunks	Occupancy Recommended	"Trunk Speed" or Average Wait for an Idle Trunk on Each Attempt
		(Seconds)
5	0.45	15
10	0.66	15
20	0.77	15
50	0.84	8

Fig. 3. Intertoll trunk capacity curves in 1902, "Delay Basis."

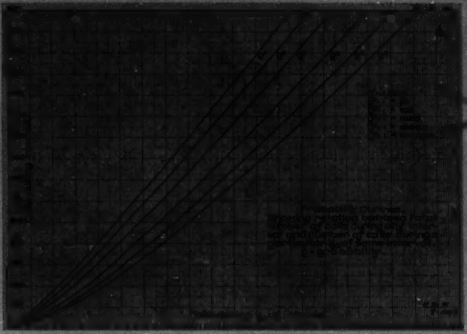


Fig. 4. Probability curves (Rorty, 1903) for relating calls in total interval to those in 1/60 of the interval.

In 1903, Rorty composed a lengthy paper entitled "Application of the Theory of Probability to Traffic Problems." In his transmittal letter of October 22, 1903 to J. P. Davis, chief engineer of the AT and T Company in Boston, he wrote:

> "I beg to hand you herewith a set of notes covering studies made by Messrs. Pennell and Fosdick and myself, to determine possible applications of the mathematical theory of probability to traffic problems.
>
> "The final results are expressed in a series of curves bearing numbers from *50-B-23* to *50-B-38*, inclusive. [Fig. 4 is a reproduction of one such curve sheet.] These curves are in the main self-explanatory. Their use is based on the assumption that the interval is divided into a number of definite smaller periods of time, and ignores the fact that a concentration of traffic or 'peak' may occur so as to be divided between two of the smaller periods that are adjacent to each other.
>
> * * *
>
> "The true theory should include all peaks without relation to definite divisions of the interval. This theory is, however, as yet undeveloped in mathematics, and we have therefore been compelled to employ the approximation furnished by the simpler theory which is outlined, among other places, in the Encyclopedia Britannica and which is restated in the attached notes.
>
> "As an example of the method of using the curves, suppose we wish to find the probability that a particular minute of an hour in which 600 calls occur will have 20 calls or more. For a ratio, between major and minor intervals, of 60, we refer to curve *50-B-24.* [Fig. 4.] The point corresponding to 600 calls in the major interval and 20 calls in one sixtieth of this period lies between the curves p^4 and p^5, showing that the probability for a particular minute is between 1 in 1,000 and 1 in 10,000. For the 60 minutes of the hour, the probability would be 60 times the above.
>
> * * *
>
> "I am not prepared to suggest that we rely largely upon theoretical figures of this kind at the present time, but can nevertheless testify that the applications of the theory thus far made have been of great value in giving approximate finality to experimental figures that we might otherwise have been compelled to look upon as inconclusive."

A few excerpts from the paper itself also dated October 22, 1903, will indicate Rorty's probability approach:

> "In what follows, an attempt has been made to calculate the distribution of calls over a short period, such as the busy hour, to calculate trunk efficiencies, etc., by means of the mathematical theory of probability.
>
> * * *
>
> "Let p denote the chance of an event happening and q the chance of its failing. If the event must either happen or fail, $p+q$ is a certainty or equals unity. In N trials the probability of the event happening a given number of times is given by one of the terms of the expansion $(p+q)^N$."

Rorty then adopted Bernoulli's normal integral

$$\Sigma' = \frac{2}{\sqrt{\pi}} \int_0^{r/\sqrt{2pqN}} e^{-x^2}\,dx \qquad (1)$$

as a suitable approximation to "the probability that the event will occur not more than $pN + r - 1/2$ and not fewer than $pN - r + 1/2$ times." Finally, "as p and q approach 1/2, . . . then . . . $(1 - \Sigma')/2$ [equals] . . . the probability of the event happening more than $pN + r - 1/2$ times." He then reproduced a normal integral table from the Encyclopedia Britannica and continued:

> "The method of compiling the data for the curves is to determine the values of $r/\sqrt{2pqN}$ for several different probabilities, such as 1 in 10, 1 in 100, 1 in 1,000, etc., and then for each probability make up curves for different ratios between the assumed smaller intervals and the total period of time.
>
> "The curves so compiled show the number of calls which there is a certain probability of equalling or exceeding during a particular interval, which is a definite fraction of a large interval containing a given number of calls."

Rorty then gave a number of examples of the use of the curves, including the value of teamwork between operators in varying group sizes, and the determination of the proportion of a month's toll business that will occur in the maximum day of the month. Typical is the one:

> "To determine trunk loads: If the average time a trunk is used per call is T minutes, then the maximum trunks will be needed just at the end of that period of T minutes during which more calls have occurred than in any other consecutive T minutes. The number of trunks also will equal the number of calls during this busiest T minutes."

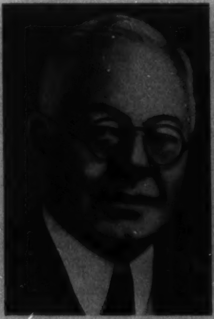
Rorty's essay was circulated widely throughout the Bell Companies and provoked great interest. He presented the substance of it in a talk before the Chicago Section of the AIEE, April 25, 1905 and as reported in the *Western Electrican*[3] a lively discussion followed. Some were skeptical that the social habits of people could be predicted by any random type of theory and illustrated the difficulties of the problem by citing examples of fires which had overwhelmed certain Chicago exchanges. Others, however, thought his work to be a valuable and even remarkable contribution to telephone literature, and predicted it would have far-reaching implications. Rorty replied:

> "The belief is common that, at the point where the human element enters a proposition, all recognized rules cease to hold. This may be true of the individual, but it is far from being true of humanity in the aggregate, and the study of popular habits and activities has thus become, either consciously, or unconsciously, an important one with corporations engaged in all branches of public service.
>
> * * *
>
> "Now, in the telephone work, we know that we can never provide for the maximum rush that may occur, for, if we stay in the business long enough, there will surely come a time when all subscribers will wish to talk at once, so that the best we can do is to provide such equipment of trunks and operators positions as will reduce to a certain predetermined small figure the probability of a complete breakdown in the service."

STUDIES OF MECHANICAL SWITCHING SYSTEMS

At the turn of the century, G. A. Campbell, who subsequently developed the loading coil and invented the wave filter, formed the first telephone research laboratory in Boston. Among that early group were such later well-known names as F. B. Jewett, E. H. Colpitts, O. B. Blackwell, and G. W. Pickard. One of the projects which shortly engaged the increasing attention of the new department was the development of automatic and semiautomatic switching systems. The circuit study work for "automatics" was directed by E. A. Gray; his 1905 associate was a young high school graduate, E. C. Molina. In the course of their studies of the economics of machine switching, Gray called Molina's attention to Rorty's paper and thus touched off a notable career in the application of probability theory to telephony.*

Gray himself was a prolific contributor to early automatic circuit design. The story of his invention of graded multiples has often been told. On Thanksgiving day, 1905, the Molinas had gone by streetcar to the north of Boston to see a morning football game with the Grays. One version is that to young Molina's great annoyance during the game—he was an avid football fan—Gray insisted on expounding his ideas for overcoming the severe capacity limitations imposed by small access Strowger-type switches.† Gray's reasoning seemed incontrovertible and a patent on graded multiples was filed at the U. S. Patent Office on July 30, 1907.


M. C. Rorty

E. C. Molina

The probability studies, which flowed from Rorty's paper and earlier empirical work, showed the economic desirability of employing trunks and switches in large groups, certainly larger than the 10-size used in the step-by-step system. It was difficult however to visualize how subscribers accustomed to counting decimally could be taught easily to work a switching system operating nondecimally. The dilemma was resolved by Molina's invention in 1905 of translation.[3] His idea arose from a study of the chapter on Scales of Notation in Todhunter's Algebra. This invention freed switches from dependence on the decimal number plan; at the same time it gained great advantages in subscriber numbering and trunking flexibility which are made use of in all American metropolitan telephone networks, and more recently in nationwide toll dialing.[4] Thus, probability and number theory had a far-reaching influence upon the design of the Western Electric Company panel and rotary machine switching systems, both of which employed the principle of translation to achieve the trunking efficiencies of large group sizes. From this time, traffic probability theory has occupied a central position in the over-all planning of switching systems, as well as in indicating the detailed provision of switching, storage, and control equipment.

EARLY QUEUING STUDIES BY THROWDOWNS

One of the prime problems requiring solution on early semimechanical switchboards was the number of calls which an operator could be expected to carry. The following extract from a lengthy AT and T Company engineering report of June 1907 (written by J. C. T. Baldwin) is illuminating as to early approaches to the delay problem:

> "Methods of Calculating Equivalent Loads: On account of the very considerable difference between the average time per call needed by an operator on the different types of boards the method of computing equivalent loads becomes a much more complicated question than it seemed at first. In considering the matter of load we feel that the number of calls per operator per busy hour cannot be represented correctly in two systems by a number in inverse proportion to the time taken to handle a call. All our experience in observing service and operating intervals leads us to believe that the operator's load increases as the time per call decreases and in a greater proportion than the reduction in time. Having this point in mind, we have used two somewhat different methods for calculating operator's loads for equivalent service. The first of these methods is by considering the subject in a semimathematical manner and checking the results by observations of operators, and the second by a method we have called a "throw down."

In the first method an application of Rorty's curves was made to obtain equitable service under a variety of assumed operating conditions.

The next section of the report describes the earliest use of which there is record of a

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*A short appreciation of E. C. Molina and his contributions appeared in the *Bridge of Eta Kappa Nu*, vol. 49, no. 2, Winter 1953, upon the occasion of his election as an Eminent Member of the electrical engineering honor society.

†Mr. Molina now denies this, and says Gray's discourse took place during their afternoon walk back to the south of Boston.

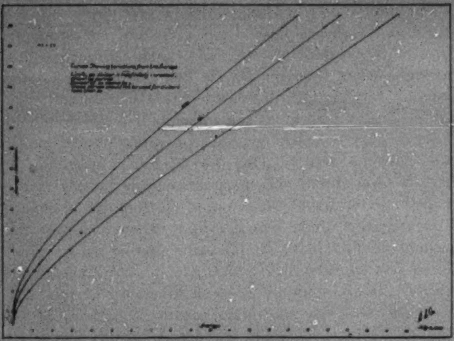

Fig. 5. "Average + Deviation" probability curves; Molina approximation (1908) to incomplete binomial summation; averages 0–20.

traffic simulation; it is captioned "Throw Down Method." Presumably the name "throwdown" came from even earlier simulations, perhaps as old as the Buffon Needle method (1777) for determining experimentally the value of π. In any event, the name "throwdown" has persisted in American traffic vocabulary to this day; it is unambiguous, it contains a certain amount of descriptiveness, and is certainly no less euphemistic than the expression "traffic simulation," or "Monte Carlo Method:"

> "'*Throw Down' Method:* In order to check this above method of calculating comparative loads, we have endeavored to represent in a diagrammatic form the time intervals needed by operators to complete calls. We have assumed in the first place that the instant an operator completes a connection she is able to take up another call; secondly, that we have perfect team work among teams of three operators; that is, a given operator can reach all calls in her own position and all calls in the two positions adjacent to hers. In order to have the calls fall in a manner approximately equivalent to calls originating in an operator's position, we divided the period under test into 1-second intervals. We then, by chance, by cutting the leaves of a book numbered consecutively from 0 to 9 or by using numbered cards, determined the precise second at which each call is to originate.
>
> * * *
>
> "In some of our tests we have assumed that all calls take exactly the same time as every other call. In other cases we have assumed a certain percentage of the calls taking longer intervals, another percentage taking an intermediate interval and another portion of the calls taking a much shorter interval, assuming that the percentage of each of these calls in various larger periods of time represented approximately the distribution of the work among operators in an exchange.
>
> * * *
>
> "From a comparatively large number of tests made in this manner we have selected the following to illustrate the results obtained [for a group of three operators].
>
> "Comparative time intervals obtained from diagrammatic representation of the busiest 10 minutes in the average busy hour for various times per operator per call:

Load; calls per hour, per operator	156	226	324	324
Time per operator, per call	14.0	10.3	7.25	7.25
Per cent of calls having drag	47	29	41	41
Average drag on all calls	3.7	1.6	1.0	1.1
Average drag on delayed calls	7.8	5.6	3.0	2.8"

Thus, the conjecture was confirmed at an early date that, with given occupancy, average delays decrease with shortened holding times. It may be noted that the numerical values of the delays on calls delayed, obtained in these primitive throwdowns nearly 50 years ago (although apparently for the busiest 10 minutes of the hour), are in not unreasonable agreement with the values: 6.3, 5.3, 3.9, and 3.9, respectively, given by present-day constant holding time delay theory.

SUBSCRIBER'S POINT OF VIEW

Several criticisms had been levelled against Mr. Rorty's probability analysis; some by the author himself. The "true theory" which Rorty had visualized had not been satisfactorily developed; in it the subinterval (1/60, 1/30, etc.) of the larger (hourly) interval should not be confined to specific "clock" intervals, but should be moved to include the largest possible number of calls wherever located. Furthermore and perhaps more important, no measure of the service given to subscribers was specifically expressed.

These twin difficulties were removed by Molina (in a memorandum of December 13, 1907) through a reorientation of the approach. He suggested that the "no delay basis trunk formula" should answer the question: "Given a certain number of calls in the busy hour and a certain number of trunks, what is the probability that all the trunks will be busy when a particular call is made?" He then demonstrated that Rorty's solution in which "The curves so compiled show the number of calls which there is a certain probability of equalling or exceeding during a particular interval, which is a definite fraction of a large interval containing a given number of calls," was also the solution to the new question asked in behalf of the particular subscriber about to place a call. Since giving service pleasing to the customer had long been the Bell objective, the Molina proposal for numerically describing service to the particular customer was quickly adopted; the "particular subscriber's point of view" has continued thereafter to be the Bell approach to the service problem.

Briefly, in this method one imagines $n + 1$ subscribers served by c paths, each subscriber placing one call at random in the busy hour with holding time p (expressed as a fraction of the hour). Observe some one (any one) of the $n + 1$ subscribers; he will place his call at random during the hour. The probability that at that instant all c paths are busy equals the probability that in the preceding holding time c or more calls were originated by the other n subscribers. That is:

$$P(c,n,p) = \sum_{x=c}^{n} \frac{n!}{x!(n-x)!} p^x (1-p)^{n-x} \qquad (2)$$

Calls meeting all-paths-busy are assumed "held" and if paths become available, finish out unused portions of their holding times. This peculiarity of the physical equivalence of the binomial, has, of course, been the subject of considerable reflection. In automatic operation, calls meeting all-paths-busy are commonly given a busy signal, requiring the customer to redial. Some will try again immediately, some will wait a few minutes, others will abandon their attempts. In Bell thinking an allowance needs to be made for the subsequent attempts and the likelihood of their not being entirely at random with respect to the existing call congestion. Where the losses are not in excess of a few per cent, the binomial summation of equation 2 has been judged to provide approximately the correct allowance.

The assumptions of constant holding time and uniform subscriber-to-subscriber loading in the original binomial derivation were not seriously restrictive. Numerous studies showed the former produced no sensible effect when abrogated; the second when lifted required substituting the general binomial expression $(p_1 + q_1)(p_2 + q_2) \ldots (p_n + q_n)$ for the simple $(p + q)^n$ expansion with a resultant slight lowering of the congestion probabilities, which although appreciated, until lately has not generally been evaluated.

The binomial therefore has long been, and continues to be, the basic low delay trunking formula used in America.

POISSON APPROXIMATION TO THE BINOMIAL

THE SECOND SHORTCOMING of Rorty's solution to the trunking problem arose from the Normal Approximation's not providing a uniformly reliable relation between load offered and probability of congestion, when the p-values in the binomial were in the 0.1 or smaller range. Since the particular subscriber's point of view required p-values commonly of 1/30 or less, more accurate determination of the binomial summation was indicated.

By a Laplacian method, Molina derived a remarkable formula in 1908 expressing the binomial summation $P(c,n,p)$ as the product of the individual binomial term at index c, and three modifying factors.[5] For p not greater than 1/30 and P not greater than 0.01, he found one factor could be ignored, leaving a formula easy to compute

$$P \doteq \frac{n!}{c!(n-c)!} p^c (1-p)^{n-c} \left(\frac{(1-p)(c+1)}{c+1-(n+1)p} \right) \left(1 - \frac{(a+p)(a-cp)}{c(c+1-a-p)^2} \right) \qquad (3)$$

Using this formula, a large binomial computing program was inaugurated and, as results became available, new curves replacing Rorty's were issued. During these calculations the chief computer noted that the probability of loss P changed but little as long as $n \times p$ was constant. He communicated this to Mr. Molina early in 1908, who then derived an approximation P to the cumulative binomial $P(c,n,p)$ under the assumptions that n and p approach the limits ∞ and 0, respectively, while their product $np = a$ remains constant. Thus, paralleling equation 3

$$P = \left(\frac{1}{1-\lambda\psi} \right) \left(\frac{a^c e^{-a}}{c!} \right) \left(\frac{c+1}{c+1-a} \right) \left[1 - \frac{a^2}{c(c+1-a)^2} \right] \qquad (4)$$

where

$$\psi = a^2 \left[\frac{2(c+1)^2 + a^2}{c^2(c+1-a)^4} \right]$$

and

$$0 < \lambda < 1$$

Here an approximation to the binomial (and Poisson) summation is obtained in terms of the individual Poisson term, $a^c e^{-a}/c!$, the latter being the limit to the binomial term in equation 3. The blocking probability is taken as $(P_1 + P_0)/2$ in which P_0 and P_1 are the values of P obtained by choosing $\lambda = 0$ and 1, respectively.

From equation 4 the curves of Fig. 5, dated July 6, 1908, were calculated. These and others show the "average + deviation" equalled or exceeded with probabilities P = 0.01, 0.001, and 0.0001 for "averages" from 0 to 200. These values are, of course, substantially identical with the cumulated Poisson distribution. Crosses (+) are shown at "average + deviations" of 2, 4, 6, 12, 18, and 20, indicating true binomial summation values for "divisors of 30" (p = 1/30). Users are cautioned that "these curves should not be used for divisors less than 30" ($p > 1/30$).

Equation 4 shortly became known as the Molina Formula, and the term $a^x e^{-a}/x!$ as the Molina Approximation to the corresponding binomial individual term. (It was not until several years later that it was learned that S. D. Poisson had much earlier obtained the same expression—which now universally bears his name.) Trunking tables and curves were drawn up from the Molina (Poisson) Formula

$$P(c,a) = \sum_{x=c}^{\infty} a^x e^{-a}/x! \qquad (5)$$

and made available for general use in Bell companies.

As noted previously, the binomial is considered the basic and general formula describing exchange traffic fluctuations; the incomplete binomial summation is believed to yield a reliable estimate of the blocking experienced from "the particular subscribers point of view," when $n + 1$ customers are served by c paths. The Poisson term and the Poisson Summation naturally became the corresponding expressions for use when the numbers of sources are large compared with the paths serving them. Thus, nearly all of the interlocal trunking plant, and the switches at many points in local systems are determined today in American practice by reference to a Poisson Table.*

LIMITED ACCESS MULTIPLES

WITH THE INTRODUCTION of large semimechanical offices in 1915, interest was intensified in studies of trunking arrangements within and between central offices. The relative advantages and efficiencies of slipped and reversed multiples, grades and other limited access plans, primary–secondary schemes, etc., were all closely studied. Means by which the traffic carried in each could be measured and administered were of but slightly less concern.

Decision to make widespread use of graded multiples was reached at about 1920, and they were accordingly introduced in the switching trains of both the panel and step-by-step systems.

American graded multiple practice has employed only the simpler graded trunk arrangements including either a small number of subgroups (seldom more than 8), each of x "individual" trunks overflowing to a common group of y trunks (with usual access, $x + y$ = 10, 20, 30, 40) or a moderate progression of individuals, quarter-commons, half-commons, and full commons. The increased gains which European investigators have demonstrated as attainable with more complicated mixtures of slips and partial commons have been viewed as probably offset by the greater cost and difficulties of making trunk rearrangements.

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*Within the Bell System, Poisson curves and extensive tables have been available for many years. Campbell[6,7] published curves and "average+deviation" tables; during World War II, tables of individual and cumulative Poisson terms were published to 6 decimals for the use of industry over the range a=0.001(0.001)0.01, a=0.01(0.01)0.30, a=0.30(0.1)15.0, a=15(1)100. Extensions of these tables for a=100(1)200 are now awaiting publication.

The approximate formulas used for graded multiple loss calculation in the Bell System, the engineering curves and tables resulting, and descriptions of certain field studies of subgroup load unbalances have been published elsewhere.[8]

Uniformly (or "radical") slipped and random slipped multiples (corresponding to Erlang's "perfect grade") were devised by A. H. Adams* and E. C. Molina, respectively, in 1917. Molina gave a "lost calls held" loss formula**

$$P_t = \frac{a^t(T-t)!}{t!}[1-P(T-t,a)]+P(T,a) \qquad (6)$$

where P_t is the probability of loss, a is the total load submitted in erlangs, T is total number of trunks, and t is number of trunks available to any one call; equation 6 has been found by many throwdowns to give accurate loss estimates, even when the theoretical assumption of all possible access arrangements for the offered load is far from met. Random slips were first introduced in Bell trunking to overcome the efficiency limitations of subgroups of 22 senders in early panel offices. They currently are used in a standard arrangement for senders in No. *4* type toll crossbar offices.

Radical slips have had little use so far in American practice, largely, one suspects, because the inventor, Adams, did not develop a satisfactory mathematical load–loss formula for predicting its performance for useful ranges of access and total trunks. (Nor apparently has anyone to date.) Early throwdowns by T. C. Fry suggested that for certain large group arrangements, the gains over split groups of switch-access size would be small. However, more recent simulation studies on smaller groups show capacities quite comparable with those of random slipped multiples. This is a field which merits additional theoretical and throwdown exploration.

EFFECT OF ERLANG'S WORK

ERLANG'S WORK first became known to Bell engineers through the publication of his paper, "Solution of Some Problems in the Theory of Probabilities of Significance in Automatic Telephone Exchanges" in the Post Office Electrical Engineers Journal (London, England) of 1918. The genius and power of Erlang's statistical equilibrium method was immediately recognized. It set in motion a train of investigations on overflow- and delayed-type traffic which continues strongly to this day. However, these form a part of another chapter of the history of trunking theory in the United States beginning in the early 1920's, which will require another occasion to summarize.

CONCLUSION

THIS HAS OBVIOUSLY been a highly abridged history of the development of switching theory in America. For example, the early studies conducted by W. L. Campbell and A. B. Smith of the Automatic Electric Company (Chicago, Ill.), which yielded permissible loads for trunks and switches, have not been mentioned. It would also, perhaps, have been of interest to compare the closely parallel thinking and development of trunking theories going on simultaneously across the Atlantic during the 1900 to 1920 period. For a comprehensive review of the latter, the reader is referred to the classic papers of G. F. O'Dell.[9]

It is hoped, however, that the present brief review of the beginnings of the application of probability theory to telephone traffic engineering in the United States will at least serve to remind younger workers in the traffic probability field whether telephone, vehicular, airplane, or other, that theirs is an old and honorable branch of applied science. And that it is one in which, during the telephone's formative years, men of great mathematical and engineering talents did bold and original thinking. As a result, the construction of service objectives was sound, and the apportionment of vast sums of money among various parts of the equipment has been proper, so that nearly 60 million telephones now provide American subscribers with a uniformly excellent local and long-distance service at a cost they have found reasonable to afford.

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Transatlantic Telephone Cable

The cableship *HMTS Monarch* has resumed operations on the transatlantic telephone cable project (see *Electrical Engineering*, March 1955, pp. 192–7).

The *Monarch* began laying 300-miles of cable across Cabot Strait between Sydney Mines and Terrenceville, Nfld., Canada in May. This portion of the system will consist of a single cable, designed to carry voices in both directions.

Last summer the *Monarch* laid the first of twin cables (see *Electrical Engineering*, August 1955, p. 741) from Clarenville, Nfld., Canada, to Oban, Scotland.

After she completes laying the Cabot Strait segment, the cableship will return to England to load for the laying of the second Atlantic cable.

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*A. H. Adams, U. S. Patent No. 1,504,301, filed Dec. 27, 1918, granted Aug. 12, 1924.
**U. S. Patent No. 1,528,982, filed Feb. 26, 1921, granted March 10, 1925.

Transient Stability Angular Increment Computer

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DETERMINATION of the transient-stability limit of a power system requires expressing the rotor angle of each machine or group of machines in the system as a function of time following the initial disturbance. This problem has been solved using miniature dynamic systems, digital computers, and differential analyzers. The latter two methods require a-c network analyzer measurements of the transfer impedances and prefault conditions. Other methods use special-purpose synchronous machine analogues coupled to the a-c network analyzer to represent power system behavior on an expanded time scale. Transient swings following a disturbance are then automatically determined. Such equipment is expensive and does not integrate readily into existing analyzer installations. At present most multimachine transient-stability problems are solved on a-c network analyzers using the step-by-step method.

The conventional procedure requires manual calculation of the angular increment for each machine over a small time interval using power output values obtained from the a-c network analyzer. Since these calculations account for a large share of the study time, additional engineers are usually assigned to a transient-stability study to hasten its completion. The tedious and repetitious nature of the calculations involved, the possibility of error, inefficient utilization of analyzer time, and the additional manpower required are factors which tend to force utilities to reduce such investigations to a minimum.

It is believed that transient-stability studies would play a greater role in power-system planning and operation if it were economically possible to obtain more rapid solutions. A low-cost special-purpose analogue computer has been developed which performs most of the swing-curve calculations, thus overcoming many of the objections to the step-by-step method.

In the step-by-step solution of the swing equations the angular increment of a machine over the *n*th interval of time, Δt, may be shown to be[1]

$$\Delta\delta_n = \Delta\delta_{n-1} + \frac{180 f \Delta t^2}{H}(P_m - P_{e_{(n-1)}}) \qquad (1)$$

where

M = angular momentum = $H/180 f$
H = inertia constant
δ = angular displacement in electrical degrees between the internal voltage of the machine and an arbitrary synchronously rotating reference frame
P_m = mechanical power input to the rotor, per unit
P_e = electrical power output to the system, per unit
f = frequency, cycles per second

Equation 1 may be arranged as follows,

$$\Delta\delta_n = K\left[\frac{P_m - P_{e_{(0+)}}}{2} + \sum_2^n (P_m - P_{e_{(n-1)}})\right]$$

where

$$K = \frac{180 f \Delta t^2}{H} \qquad (2)$$

This expression is calculated by the described computer, one of which is required for each machine group.

The determination of $\Delta\delta_n$, as shown, requires subtraction, addition, storage, and multiplication. Each computer unit consists of an input dial and magnetic clutch assembly driving a multiturn potentiometer with associated circuitry. Setting the input dial to P_m (the prime mover input), engaging the magnetic clutch and turning the input dial to P_e (the electrical power output), performs the subtraction $P_m - P_e$, and stores this quantity in terms of the slider position of the multiturn potentiometer. The voltage developed between the slider and a reference point is proportional to the angular increment and is measured by a high-input-impedance digital voltmeter which has been programmed to display the angular increment directly in degrees.

The input, storage, and output elements introduce errors. The input dial setting contributes the only cumulative error in the angular increment. Over one interval in a typical study, the input dial setting introduces a maximum possible error of ±0.05 degrees and the other sources of error introduce a maximum possible noncumulative error of ±0.08 degrees. The total error is considered negligible when within the phase-angle measuring ability of the a-c network analyzer.

Operation of the computer consists of setting the input dial to P_m (the prime mover input), engaging the clutch, and turning the dial to P_e (the electrical power output), as read from the a-c network analyzer. The sign and magnitude of the angular increment instantly appears as a numerical display. Addition of this increment to the previous angle yields the new rotor angle.

With a 3-man a-c network analyzer crew, the new rotor angles are obtained for any size multimachine transient-stability study upon completion of the analyzer power output readings. Use of the described angular increment computer will result in considerable savings in time and manpower during transient-stability studies.

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Mechanized Tree Trimming

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An average saving of $50 per mile has been realized through the use of mechanized tree-trimming equipment by power companies. A system for utilizing this equipment most effectively, as planned by one utility, is presented.

TWENTY-FIVE HUNDRED SQUARE MILES, covering all or part of six New York counties, are serviced by the Central Hudson Gas and Electric Corporation, with headquarters in Poughkeepsie, N. Y. Included in this widespread area also are the cities of Beacon, Newburgh, and Kingston, but its territory is predominantly rural, including some 7,000 farm customers and the popular Catskill Mountain vacationland. More than 4,000 miles of line carry Central Hudson's electric power to its approximately 110,000 electric customers. Substantial maintenance problems are posed by such a widespread electric network, and tree trimming is an important operating function in preventing power failures.

Fig. 1. Tree-trimming crew pictured with two Hydro Sky-Workers. Crow's nest and boom stow away for road travel.

If growing trees are not to cause damage to the power lines, with accompanying interruption of service, their branches must be trimmed back periodically. Improvement of electric service is Central Hudson's primary purpose in its tree-trimming program. Weak and damaged limbs, which fall upon power lines during a storm or heavy winds, are the leading cause of power failures in the system.

3-YEAR CYCLE

THE PROGRAM at Central Hudson calls for trimming trees on a 3-year cycle; that is, an effort is made to trim trees along a given line every third year. It has been the company's experience that tree growth beyond the third year becomes progressively harder to handle, both in terms of time and expense. The crews try to trim back about 6 feet from primary circuits, but this is not always possible.

The tree-trimming crews take pains not to alter the shape of a tree, and in a large number of cases the men are even able to improve upon the symmetry of customers' trees. As a result of their reputation for careful treatment of trees, the crews are favorably received throughout the territory. In addition, the tree-trimming operation affords the company an opportunity to contact most of its customers personally over the 3-year cycle to receive permission to trim trees along its lines on private property. The firm recognizes this contact as a valuable opportunity to improve its customer relations and to familiarize its customers with company concern for his property and his electric service.

Until recently, in common with other utilities, the company handled tree trimming through use of men equipped with climbing ropes, great physical stamina, and courage. The work was difficult and arduous; in addition, long training was necessary to make a climber skillful, and the rigorous requirements of working aloft permitted him only a decade or so of top productivity.

Mechanized equipment, of course, had been in use insofar as considered practical. Chain power saws, for example, helped materially in cutting up tree limbs on the ground; however, these saws could obviously not be used aloft by a ropeman. Conventional aerial ladders, too, were used, but only to a very limited extent—for their range could be of assistance only in a relatively few tree-trimming problems. In other words, mechanized equipment could generally be used only for ground operations, not for the time-consuming and oftentimes hazardous aerial work.

In keeping with the company's policy of continually seeking improved operating performance, with consequent benefit to the customer, the search therefore was on for a better and less expensive way to trim trees.

THE HYDRO SKY-WORKER

IN JANUARY 1953, Central Hudson had three Hydro Sky-Workers delivered. This initial purchase, from the Maxwell Equipment Company of Milford, Conn., was in reality a "trial order." Since the very first Sky-Worker had been built just 2 years before, only eight other utilities had placed orders up to this time. Although the experience of these companies had been favorable, enough time had not elapsed for forming definitive conclusions. Central Hudson, therefore, put the new machines to work trimming

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trees and began to evaluate their performance (Fig. 1).

Basically, the Sky-Worker is an hydraulically operated boom for carrying workers aloft and maintaining them on a constant work base at any required level within limitations of the boom (Figs. 2 and 3). Equipped with either one or two crow's nests, as required, the device rotates upon a turret mounted on a truck. For the average man, elevation of the boom can provide any working height up to 42 feet above ground, while rotation of the turret through a 400-degree arc—40 degrees past full circle—provides wide lateral reach. A set of controls for guiding the boom movements is placed in the crow's nest, and an identical set is placed at the level of the truck; full movement of the boom can, therefore, be accomplished from either point. Stabilizing outriggers, as well as a leveling mechanism, insure the crow's nest of an upright position at all times. Insulation of the upper boom, plus use of laminated resin-impregnated Fiberglas in the construction of the crow's nests, eliminates the possibility of electrical shock through contact with a live power line.

Central Hudson, from the beginning, has found this hydraulic lift valuable. The three original machines were augmented by two units in 1954 and another two in 1955. Since the seventh unit has not been placed in service, evaluation of the machines' performance is based on the first six units purchased. This evaluation is, quite frankly, startling.

COST COMPARISON

These six Sky-Workers cost the company $101,500. Certain allied equipment was purchased for use with the machines: two chippers (for grinding up severed limbs and branches); two dump trucks (for hauling away the tree chips); and two suburbans (for transporting tree-trimming crews to and from the job). This allied equipment cost $18,500, bringing the over-all investment in tree-trimming equipment to $120,000.

What savings have these devices produced? To interpret this evaluation correctly, attention must obviously be focused on tree trimming in the urban areas, as distinguished from the trimming operation in rural areas.

In the City of Poughkeepsie, for example, the tree-trimming work carried on with the company's new mechanized equipment resulted in substantial reductions in cost, as compared with similar trimming work by the old method. In the rural areas, for trees trimmed since the lifts came on the scene, the savings have been approximately $50 a mile.

In view of Central Hudson's experience with this equipment throughout the system in both urban and rural areas, this statement can be made: With all trimming on Central Hudson circuits being done on a 3-year cycle, the average saving per mile through use of these machines will be at least $50.

In 1955, Central Hudson's hydraulic lifts trimmed about 1,200 miles of line. Therefore, with all trimming on the 3-year cycle, the annual saving, based on 1955 performance, would amount to $50 × 1,200 miles or $60,000. Since $120,000 has been invested in the six units and allied equipment, it is estimated that the saving over a 2-year period would pay for all the equipment.

Central Hudson estimates the life of each lift at about 10 years. The truck on which it is mounted will have to be replaced at least once in this 10-year span, but it is believed that this expenditure will be relatively small. Accordingly, over a given 10-year span of trimming on the 3-year cycle, experience indicates that the Sky-Workers will pay for themselves in 2 years and, during the remaining 8 years, save some $60,000 a year for a total saving of $480,000.

In making these cost comparisons, Central Hudson has charged against the hydraulic-lifts' operations such factors as holidays, vacations, sick time, insurance, pensions, as well as depreciation of the equipment, overhead, costs of tools, and off-time because of inclement weather. The cost comparison, therefore, is a realistic one.

The company's chippers, mentioned earlier as having been purchased for use with the hydraulic-lift units, have contributed a great deal to their over-all effectiveness. They have provided an excellent means for swift reduction to chips of the tree limbs cut by the lift operators; disposal of tree limbs has therefore been made easier.

Fig. 2 (right). Duplicate set of controls for guiding the boom movements is in the crow's nest.

REASONS FOR THE SAVINGS

The heart of the considerable savings resulting from use of the Sky-Workers lies in one central fact: all a tree trimmer's efforts are now devoted to tree trimming, no longer, in major part, to "getting up there." (A rope man may at times use up an hour's time to get in 12 minutes work.)

But there are other benefits, too, which have proved significant:

1. The natural form and symmetry of the customers' trees can be better maintained than heretofore and, in many instances, can be improved. Customers' satisfaction with the quality of work and their recognition of the benefits to the general health and future growth of a tree, resulting from proper trimming, is evidenced by their willingness to permit retrimming by Central Hudson's crews.
2. A tree trimmer, with only 6 weeks' training on a hydraulic lift, is more productive than a rope man who has had many years of experience.

Fig. 3 (left). Elevation of boom can provide any working height up to 42 feet above ground.

3. Tree trimmers, whether experienced or inexperience, can look forward to a much longer period of productivity. Central Hudson expects a typical Sky-Worker operator to be trimming trees many years longer than the average tree worker equipped with climbing gear under the old method.

4. The lift is equipped to permit the use of pneumatic pruning tools from the crow's nests. This advantage alone results in great saving of time over the use of hand tools. In cleaning up after a storm, the power tools are "worth their weight in gold." (On several occasions, Central Hudson has sent their units, with full crews, to assist neighboring utility companies during times of emergencies.)

5. Finally—and to Central Hudson's thinking—the biggest advantage of all are the safety benefits. The hydraulic-lift operator must, according to company rules, wear a hard helmet and safety glasses and be strapped in his crow's nest. The power tools contribute still more to his safety. There is no safety comparison between the lift operator and the rope man—the latter is unavoidably exposed to rope breakage, tree-limb breakage, hazards of using hand tools aloft, and greater risk of making human mistakes.

ORGANIZING THE SKY-WORKER'S OPERATIONS

A SYSTEM has been worked out by Central Hudson for utilizing their Sky-Workers, which permits most effective use of this equipment. Eight men are assigned to each group of three units under normal operating conditions. One of them, the chief line clearance man, directs the operations of the three units. Two others—a line clearance man first class and a line clearance man second class or groundman—man each unit. The eighth man handles the chipper and the dump truck, that serve all three units. When one of the men is absent, the chief line clearance man assists temporarily.

In conclusion, one point should be particularly stressed: A utility's investment in these machines can be viewed legitimately as insurance against excessive time loss in making line repairs following a storm. The value of this contribution—both in customer relations and in effective company operations—certainly is of great importance.

Probability Calculations for System Generation Reserves

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Interest in a new approach to the generator capacity reserve problem stemmed from an apprehension that past methods were becoming inadequate because of the growth and increasing complexity of generating and transmission components. It is apparent that the probability theory fulfills the requirements, for both the current and the future planned operations.

TO INVESTIGATE the use of the probability theory,[1,2,3,4] for determination of generator capacity reserves by the application of probability methods, was a motivating factor in initiating this study at the Los Angeles (Calif.) Department of Water and Power. It was specifically desired to check the results of the probability calculations with the then current thinking respecting reserve requirements. In addition, the need of evaluating the effect of the trend to ever-larger generating units on the system reserve requirements was pertinent.

Records of emergency outages of major equipment for a period of approximately 8 years preceding the study were reviewed, so as to assign actual historical outage factors to each element of the system entering into the calculations. In instances where equipment had experienced no emergency outages during the period of review or the outage records were clearly out of line, typical outage factors for similar equipment derived from the literature on the subject

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were used. There was close agreement between the calculated service reliability, based upon the probability theory, and the actual service reliability, which had been experienced, justifying further calculations utilizing the probability theory.

BASIC THEORY

It is convenient to divide the basic theory of probability calculation pertaining to system reserve requirements into four parts.

1. *Definition of Statistical Probability.* If, over a long period of time, a piece of equipment has operated a total time R and has been on forced or emergency outage the total time O (omitting planned shutdowns), the probability q of forced outage can be expressed as

$$q=\frac{O}{R+O}$$

Likewise, the probability p of the equipment remaining in operation becomes

$$p=\frac{R}{R+O}$$

and

$$p+q=1$$

Hereafter, q will be called the forced outage factor, p the operating factor, and $R+O$ the demand time.

2. *Multiplication Principle.* If p_1 is the probability of generator G_1 operating and p_2 is the probability of generator G_2 operating, the probability of both operating simultaneously is the product of the two probabilities, or p_1p_2. This principle applies when the operating conditions of the two generators are independent, with the operating condition of one generator having no effect on that of the other. Extension of the multiplication principle to more than two generating units, or components of the system, will be considered later.

If p_1 is the probability of generator G_1 operating and q_2 is the probability of G_2 being on forced outage, the probability of the first unit operating and the second unit being on forced outage is, by the multiplication principle, p_1q_2. Likewise, if q_1 is the probability of G_1 being on forced outage and p_2 is the probability of G_2 operating, by the multiplication principle, q_1p_2 is the probability of the first unit being on forced outage and the second unit operating.

3. *Addition Principle.* The probability of the occurrence of either one or the other of two "mutually exclusive" events is the sum of the respective probabilities. Thus, the probability of having either of the two units on forced outage is $p_1q_2+q_1p_2$. "Mutually exclusive" means the occurrence of one event excludes the occurrence of the other event.

The multiplication and addition principles may be demonstrated by computing all possible operating conditions (excluding planned outages) of the two generators in parallel, thus

$$(p_1+q_1)=1$$

and

$$(p_2+q_2)=1$$

$$(p_1+q_1)(p_2+q_2)=p_1p_2+p_1q_2+q_1p_2+q_1q_2=1$$

Equating to 1 signifies that all possible probability combinations of operation and forced outages are included. In the equations, p_1p_2 is the probability of both units operating, p_1q_2 is the probability of first unit operating and second unit on forced outage, q_1p_2 is the probability of first unit on forced outage and second unit operating, q_1q_2 is the probability of both units on forced outage, $p_1q_2+q_1p_2$ is the probability of any one unit on forced outage, $p_1p_2+p_1q_2+q_1p_2$ is the probability of no unit or one unit on forced outage, $p_1q_2+q_1p_2+q_1q_2$ is the probability of one or more units on forced outage. For two units of the same capacity and outage factor the expansion becomes

$$(p+q)^2=p^2+2pq+q^2=1$$

4. *Expectation.* Expectation is a mathematical method of placing a value on a probable event and may be described as the product: "the probability of an event occurring" times "the results realized if the event occurs." For example, from a bowl containing ten tickets, one of which will award a $10 prize, what is a fair value of the random drawing of one ticket? The probability of winning is one tenth and the prize is $10, therefore, the value of the expectation is one tenth of $10 or $1. After the chance is taken, the individual will receive either $10 or nothing, but upon repeating indefinitely the same conditions the average value of each random drawing of one ticket will be $1. If among the ten tickets in the bowl, there is one ticket which awards a $10 prize and another ticket which awards a $5 prize, the probability of winning $10 is one tenth and the probability of winning $5 is one tenth. Then, the expectation or fair value of drawing one ticket is: one tenth of $10 plus one tenth of $5 equals $1.50.

MECHANICS OF THE STUDY

All components of generation and transmission to the system at locations on what is called the belt line are included in the reliability calculations. The belt line is a

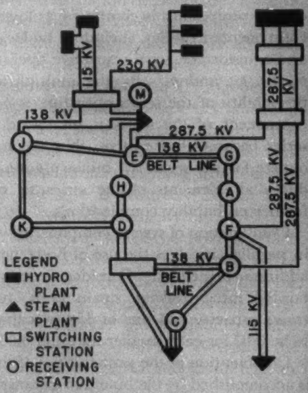

Fig. 1. Schematic diagram of system.

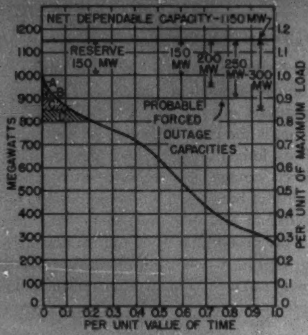

Fig. 2. Load duration curve.

138-kv double-circuit tie, connecting into a loop the large substations at which the transmission circuits from generation sources enter the system. Such large substations are called receiving stations to distinguish them from other substations designated distributing stations. The latter are generally supplied from the receiving stations at 34.5 kv. The belt lines and all outgoing circuits from the receiving stations are classified as distribution, and are not considered pertinent to the reliability of supply to the bulk-power receiving points of the system. Fig. 1 is a schematic diagram of the generation, transmission, and belt-line connections.

Actual calculations commence with the combination of the selected forced outage probabilities, applying to each component of the system by the previously described methods of multiplication and addition. In this respect, physical arrangement of the components, whether in series or in parallel, and such factors as steam header or package unit, excess boiler capacity or just sufficient boiler capacity for plant output, dictate the mathematical approach to the probability combination. In the series arrangement, such as a package unit, where the forced outage of one or more components renders the entire series inoperative, the forced outage probability is computed as follows: Consider four components in series, including boiler, turbine, generator, and transformer, with respective operating probabilities of p_1, p_2, p_3, and p_4. By the multiplication principle, the probability of the series operating is $p_1p_2p_3p_4$. When any component of the series is on forced outage, the entire series becomes inoperative, thus the probability of forced outage for the series is 1 minus $p_1p_2p_3p_4$. This formula reduces all elements of the series to one unit for use in further probability combinations.

Combination of system components, which are connected in parallel, involves the use of both the multiplication and addition principles. Consider a generating plant containing three package steam units, two of 25-megawatt (mw) capacity and one of 35-mw capacity, and assume q to be 0.02 for each smaller unit and 0.03 for the larger unit.

Combination of the probabilities of the two smaller units is accomplished by the binomial expansion, thus

$$(p+q)^2=(0.98+0.02)^2=1$$
$$0.9604+2(0.0196)+0.0004=1$$
$$0.9604+0.0392+0.0004=1$$

The probability of zero mw being on forced outage or both units operating is 0.9604. The probability of a specific 25-mw unit being on forced outage, with the other unit in operation, is 0.0196. There are two mutually exclusive ways of having one unit on forced outage with the other unit operating. Therefore, the probability of having 25 mw on forced outage is 2(0.0196)=0.0392. Finally, the probability of having 50 mw, or both units, on forced outage is 0.0004.

Probabilities applying to the 35-mw generating unit (0.97+0.03) are combined with those of the two 25-mw units (0.9604+0.0392+0.0004) in a similar manner, thus

$$(0.97+0.03)(0.9604+0.0392+0.0004)=$$
$$\overset{A}{(0.931588)}+\overset{B}{(0.038024)}+\overset{C}{(0.000388)}+$$
$$\overset{D}{(0.028812)}+\overset{E}{(0.001176)}+\overset{F}{(0.000012)}$$

Tabulation of the Expansion

Term	Probability	Forced Outage, Mw	Units on Forced Outage
A	0.931588	0	0
B	0.038024	25	1
C	0.000388	50	2
D	0.028812	35	1
E	0.001176	60	2
F	0.000012	85	3
	1.000000		

The probability factor applying to each term represents the portion of the demand time that the associated capacity may be on emergency outage.

Other components of the system are combined with the three package units by extension of the process until all elements are included in the probability combinations. Care must be exercised when combining transmission elements with sources of generation. In the example containing two 25-mw and one 35-mw units, assume two single-circuit transmission lines between the generating station high-voltage bus and the belt line. Each line, capable of transmitting the entire output of the three generating units, is assigned an outage factor $q=0.002$.

Probability factors of the two transmission lines are combined by the binomial expansion, thus

$$(0.998+0.002)^2=0.996004+0.003992+0.000004$$

The three terms represent the probabilities of no outage, one line out of service, and both lines out of service, respectively. Under the conditions represented by the first and second terms of the expansion, there is no generation curtailment resulting from transmission line interruptions. These are mutually exclusive events and additive. Probability of transmitting the entire output of the generating plant to the system is

$$(0.996004+0.003992)=0.999996$$

Expansion required to combine the outage probability of transmission with the outage probabilities of the generating units is

Generating Plant		Results of the Expansion Including Transmission	
Forced Outage, Mw (1)	Probability (2)	Forced Outage, Mw (3)	Probability (4)
0	0.931588	0	0.931584*
25	0.038024	25	0.038024*
50	0.000388	50	0.000388*
35	0.028812	35	0.028812*
60	0.001176	60	0.001176*
85	0.000012	85	0.000016
	1.000000		1.000000

*(Column 2) times (0.999996) = probabilities of forced outages shown in Column 3 with one or both transmission circuits in service.

The factor 0.000012 is the probability of losing all three generating units when either one or both transmission circuits are in service. However, 85-mw capacity will be separated from the system when both transmission lines are on emergency outage. The probability of that event is 0.000004. Addition of these two probabilities gives 0.000016, which is the probability of losing 85 mw on emergency outage either caused by the loss of all three generating units or resulting from the separation of the plant from the system.

Combination of all component probabilities of the system produces a large number of terms, especially when there is a considerable range in the output capabilities of the individual generating units. Sample calculations have been made to study possible reduction in the number of terms and, for the department's system, it is felt that proration of the forced outage probabilities to multiples of 25 mw produces reasonable results.

Assume it is desired to eliminate the 35-mw probability term in the previous tabulation. Linear proration between 25 mw and 50 mw assigns 15/25 of the outage factor for 35 mw to that of 25 mw, and 10/25 of it to the outage factor applying to 50 mw. Thus, the outage probability 0.038024 is increased by 15/25 of 0.028812 and the new value for 25 mw becomes 0.055311. Thus, in a similar manner, the new factor for 50-mw emergency outage becomes 0.011913. But, the 50-mw outage condition is further modified by proration of the 60-mw outage condition. Continuation of the process to reduce the outage values in the previous tabulation to multiples of 25 mw results in the following:

Forced Outage, Mw	Probability
0	0.931584
25	0.055311
50	0.012618
75	0.000480
100	0.000006
	0.999999

After these manipulations it is not unusual that the sum of the probabilities is slightly different from one. Ordinarily, the largest factor would be adjusted to make the sum unity.

In describing the mechanics of the probability method, it has been demonstrated how individual outage factors are combined to obtain the probability of various amounts of capacity on forced outage, including generation and transmission to the belt line. A knowledge of the probability of losing various quantities of supply to the belt line is not a measure of the effect of their loss upon the load to be served. This effect is represented on the department's system by the term index of reliability. Index of reliability is defined as the ratio of the load served to the load available. Actual indexes of reliability covering approximately 15 years are available from records, and the bench mark with respect to quality of service is that system reserves should be adequate to maintain not less than the historical index of reliability.

To measure the effect of probable forced outages on the load to be served requires the use of load-duration curves. These represent graphically the system load demands in descending magnitude. Fig. 2 is a representative load-duration curve typical for December. Peak demand is shown to be 1,000 mw and net dependable capacity 1,150 mw. All capacity is assumed to be in operation in the month of December.

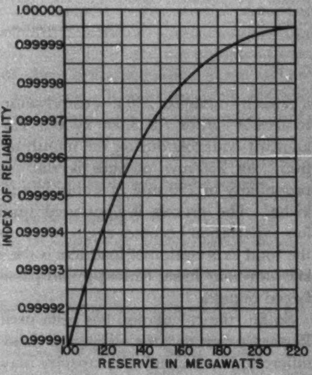

Fig. 3. Reliability vs reserve.

It is obvious that any combination of emergency outages totaling 150 mw or less will not affect the load. If the total exceeds 150 mw, the load may or may not be affected, depending upon when the forced outages occur. If the maximum system demand were constant throughout the month, 100-per-cent load factor condition, every outage in excess of 150 mw would cause some load curtailment. It is apparent from the shape of the load-duration curve that the expectation of load curtailment resulting from outages slightly in excess of 150 mw is relatively small. The maximum effect on the load of a capacity outage of 200 mw, in the month represented, would be area *A* which is 372,000 kwhr. The 372,000 kwhr is comparable to the $10 prize referred to in describing expectation, but the expected kilowatt-hour loss from the probable forced outage of 200 mw is much less because the probability factor associated with that loss is only 0.006710. Actually, the expected loss is the product of the probability factor and the total kilowatt-hours in area *A* or 2,496 kwhr. Likewise,

Table I. Determination of Expected Index of Reliability Generation to the Belt Line, Month of December

Forced Outage, Mw	Probability of Forced Outage	Amount Reserve Is Exceeded, Mw	Peaking Energy, Kwhr	Expected Energy Loss, Kwhr
	(A)		(B)	(A×B)
0	0.680562	0	0	0
25	0.041858	0	0	0
50	0.019105	0	0	0
75	0.097340	0	0	0
100	0.115868	0	0	0
125	0.010850	0	0	0
150	0.008923	0	0	0
175	0.015515	25	93,000	1,443
200	0.006710	50	372,000	2,496
225	0.001053	75	930,000	979
250	0.001099	100	1,823,000	2,003
275	0.000798	125	3,218,000	2,568
300	0.000187	150	5,189,000	970
325	0.000058	175	7,812,000	453
350	0.000050	200	11,309,000	565
375	0.000017	225	15,736,000	268
400	0.000004	250	21,167,000	85
425	0.000002	275	27,863,000	56
450	0.000001	300	35,452,000	35
	1.000000	Total expected energy loss by forced outages to belt line		11,921

NOTE: Net dependable capacity = 1,150 mw. Peak demand = 1,000 mw. System load available for the month = 446,000,000 kwhr.

$$\text{Expected index of reliability: } 1-\frac{\text{Expected energy loss}}{\text{System load available}}=1-\frac{11,921}{446,000,000}=0.999973$$

a capacity outage of 250 mw could cause a curtailment equal to area $A+B$, or 1,823,000 kwhr. However, the expected kilowatt-hour loss during the month of December resulting from the 250-mw outages is the product of 0.001099, probability of 250 mw in Table I, and 1,823,000 or 2,003 kwhr. The process is continued until the kilowatt-hour loss expectation becomes negligible. As shown by Table I, the total expectation of load loss is the sum of the expected kilowatt-hour losses caused by all possible combinations of forced outages.

So far, the calculation has been performed for a month. During other months, the peak load demands may be different, but dependable capacity may also change. The shape of the load-duration curve may vary with the season of the year. It is desirable to make the calculation for each month of the year, taking into account the representative load-duration curve for each month and anticipated reductions in net dependable capacity, caused by equipment overhauls and factors, such as reduced operating heads resulting from drawdown at hydroelectric plants.

It is apparent from the foregoing that considerable laborious calculations are entailed in obtaining the expected annual energy loss similar to the monthly figure shown on Table I. To relieve engineers from such work, a small digital computer has been used for obtaining the combinations derived by multiplication and addition principles. This has helped, but it appears that full advantage of automatic machine computation cannot be realized until a larger computer can be used. A medium-sized computer is expected to be available late in this calendar year, and an attempt will be made then to program the entire probability problem into the computer.

Because of the volume of work necessary to repeat the computation shown by Table I for each month, sample calculations were made in order to compare results from 12 months with results omitting certain months. The present thinking is that calculations for three or four seasonally spaced months are necessary. April, August, October, and December are most representative for the Power System of the Department of Water and Power. Annual index of reliability is the result desired from the calculations. This is the ratio of the sum of the monthly loads, after reduction for expected load losses resulting from emergency outages, and the estimated total available kilowatt-hour load for the year.

If the index of reliability from the calculations for a reserve of 150 mw is consistent with the long-time average historical index, no further calculations need be made. But, the calculations must be repeated, using other values of reserve, if the calculated index of reliability is unsatisfactory. The relationship between index of reliability and reserve capacity in megawatts at the time of annual system peak demand is shown by Fig. 3. This curve represents results of several calculations similar to those of Table I.

PROBABILITY METHOD IN SYSTEM PLANNING

Calculations of generating capacity reserves provide useful information for planning system generation requirements for future years. Among the factors which establish the installed generating capacity required at any future time is the amount of reserve that will be needed. This reserve capacity will depend upon the load to be served, output capabilities, and outage factors of the individual components of supply to the belt line, as well as the index of reliability desired. If larger generating units are to be installed, larger reserves will be required. Hence, the timing for installation of new generating capacity will, to some extent, be dependent upon the total system reserve requirements.

It can be shown by probability calculations that generating units, up to a certain size, can be added to a system without any increase in reserve. Beyond that size, moderate increases become necessary and, as the generating unit size continues to increase, greater and greater amounts of reserve are needed. A point can be reached where the increased amount of reserve, because of the addition of an unusually large generating unit, renders the installation of the large unit uneconomical. Greater over-all economy could be achieved if a smaller unit were installed. However, the conclusion in this respect cannot be based upon

Table II. Effect of Unit Outage Factor on Reserve Index of Reliability = 0.999984

Net Generating Capacity Additions*		Total Net Dependable Capacity, Mw	Effect of Outage Factor			
			Lower		Higher	
Mw	Units		Unit Outage Factor	Required Reserve, Mw	Unit Outage Factor	Required Reserve, Mw
414	5	1,025	0.03	138	0.04	150
186	2	1,211	0.03	158	0.04	170
145	1	1,356	0.04	195	0.05	215
145	1	1,501	0.04	223	0.05	250
148	1	1,649	0.04	249	0.05	278
148	1	1,797	0.04	270	0.05	300

*Steam generating package unit additions to a basic system of 611-mw net dependable capacity.

Table III. Effect of Unit Size on Reserve
Index of Reliability = 0.999984, Outage Factor = 0.04

Net Generating Capacity Additions,* Mw	Total Net Dependable Capacity, Mw	Required Reserve, Mw	Net Generating Capacity Additions,* Mw	Total Net Dependable Capacity, Mw	Required Reserve, Mw
	1,797	270		1,797	270
−75**+150	1,872	290	−75**+200	1,922	319
150	2,022	306	200	2,122	355
150	2,172	321	200	2,322	382
150	2,322	335	200	2,522	403

*Each 150-mw or 200-mw item is one steam-generating package unit.
**Retirement of two steam units: one 35 mw, one 40 mw.

Table IV. Effect of Unit Size on Reserve
Index of Reliability = 0.999984, Outage Factor = 0.05

Net Generating Capacity Additions,* Mw	Total Net Dependable Capacity, Mw	Required Reserve, Mw	Net Generating Capacity Additions,* Mw	Total Net Dependable Capacity, Mw	Required Reserve, Mw
	1,797	300		1,797	300
150	1,947	321	200	1,997	356
−75**+150	2,022	356	−75**+200	2,122	402
150	2,172	373	200	2,322	432
150	2,322	389	200	2,522	460

*Each 150-mw or 200-mw item is one steam generating package unit.
**Retirement of two steam units: one 35 mw, one 40 mw.

installation of one unit only, because as additional units of the same size are added to the system the increments of reserve decrease and approach zero. The answer to the problem involves a study of system capacity additions over an extended period of time.

Tables II through IV show results of probability calculations applying to future generating capacity additions. Table II shows the effects of differences in outage factors on system reserve requirements over a period of years in which net dependable system capacity might increase from 1,025 mw to 1,797 mw. Calculations are based on an index of reliability 0.999984.

Table III shows the effects on system reserve of the addition of four 150-mw units to the 1,797-mw net dependable capacity of Table II (with the retirement of 75 mw of capacity), as compared to the effects on system reserve of the addition of four 200-mw units (with the retirement of 75 mw). The outage factor for all additions, 150 or 200 mw, was assumed to be 0.04 and the desirable system reliability index 0.999984. Table IV shows results of calculations similar to those of Table III, except the outage factor assigned to all additions was 0.05. Table III is a continuation of the portion of Table II having the lower outage factors, whereas Table IV extends the portion of Table II with the higher outage factors.

Retirement of 75 mw is indicated in Tables III and IV. A computer is helpful when capacity retirements enter the calculations, as apparently there is no way to eliminate the forced outage effects of one element of generation or transmission without repeating the calculations and omitting the data applying to the retired components.

CONCLUSION

Timing of the installation of new generating capacity depends, in no small degree, on the amount of generating reserve capacity required. The reserve, in turn, is affected by the size, type, and location of the generating capacity. Recommendations as to the most desirable course to follow should be derived from studies whose elements are properly comparable. Generation reserve is a large factor in such studies.

Mathematical results following systematic methods are highly desirable for all elements of economic studies made to develop decisions pertaining to system planning. The prominence of generation reserve in economic studies of system generation requirements emphasizes the need for a systematic mathematical derivation of these reserves. That need may be met by the use of the probability method. The method is used by the Department of Water and Power for determination of generation reserve requirements both for current and future operations.

No calculation can produce results which are better than the basic factors used in the formulas. Reliability of the probability theory is not questioned but the need is recognized for improvement in the outage factors applied to the many components of the generation and transmission systems. Because most factors now used are obtained from relatively short records, there is an inclination to use higher factors than may be necessary. Results probably are too conservative. As more information on generation and transmission component reliabilities is compiled, outage factors will become more representative. In any event, the better the data, the more reliable will be the results.

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Test Film Developed

A new 16-mm test film that measures registration, aperture size, resolution, shutter timing, centering of the image, steadiness of its own test image with respect to the perforation, and also provides a "thousandths scale" for measuring film movement in double-exposure testing of printer steadiness has been announced by the Society of Motion Picture and Television Engineers, New York, N. Y. This film will be used for quality control by manufacturers of projectors, in film laboratories to adjust printers, and for precise alignment of black-and-white- and color-television film chains. Development work on the film was done over a period of $2^1/_2$ years at the George W. Colburn Laboratory, Chicago, Ill.

Magnetic-Amplifier Control of Switching Transistors

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THE POWER-HANDLING ABILITY of a transistor can be increased by about a factor of 10, relative to class *A* operation, by operating in the switching mode.[1] Much greater stability also is achieved, inasmuch as a switching transistor operates only at cutoff or saturation and minor variations in the linear transistor parameters do not affect operation. These features have been exploited in a number of recently developed devices which use the transistor as a switch. The advantages of the switched mode of operation are similarly attractive in constructing a linear amplifier. The average output of a switching transistor can be linearly controlled if ratio of "on" time to "off" time is varied by a pulse-width modulation technique. A series of circuits have been developed which use the variable-width output pulse of an audio-frequency magnetic amplifier as a means of linearly controlling the output of switching transistors.

If a magnetic amplifier is operated from a square-wave a-c source, it has a rectangular output pulse whose width varies linearly with control. Such a device is ideally suited as a means of pulse-width modulating power transistors. An audio-frequency transistor inverter can provide the necessary square-wave source for a magnetic amplifier; in addition, the use of a high supply frequency allows the magnetic components to be greatly reduced in size and the amplifier performance to be greatly increased.[2] A basic circuit for controlling linearly the average output of switching transistors with this technique is shown in Fig. 1. The magnetic amplifier serves not only as pulse-width modulator, but also as a high-gain preamplifier. Thus, high over-all gain as well as high power and linear control are achieved by the circuitry.

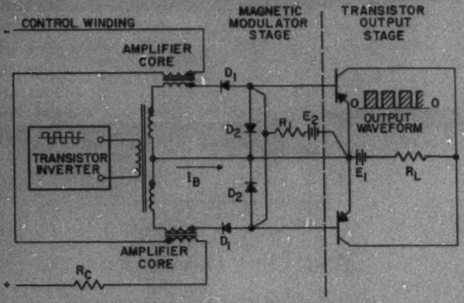

Fig. 1. Basic magnetic-transistor amplifier circuit.

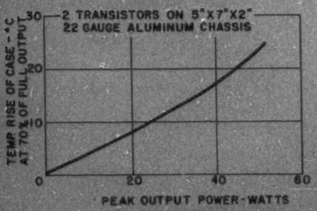

Fig. 2. Transistor temperature rise at pulse repetition rate of 10,000 pulses per second.

It is desirable to operate the amplifier at a high supply frequency in order to obtain minimum response time and maximum magnetic-amplifier performance. A limitation is set on the maximum operating frequency because the average transistor dissipation rises rapidly as the transistor switching time becomes an appreciable portion of a half cycle. Therefore, the advantages of switched operation disappear. With presently available power transistors, switching rates in the range of 1 kc to 10 kc appear to be most advantageous.

The circuit of Fig. 1 has been constructed using two Minneapolis-Honeywell Regulator Company type *H-2* transistors in the output stage. The amplifier operates at a frequency of 5 kc and has a maximum output of 47 watts. With a minimum control circuit resistance R_c of 52 ohms, the power gain is 15×10^6 (72 db), the voltage gain is 3,800, and the response time is 85 milliseconds. Gain can be traded for shorter response time, and with R_c of 20,000 ohms the power gain becomes 32,000 (45 db) and the response time 0.2 milliseconds. The temperature rise of the transistor mounting base as a function of peak output power is shown in Fig. 2. The data correspond to a 70 per cent conduction time, which is approximately the point of maximum transistor dissipation. It may be noted that the temperature rise increases disproportionately fast at high output power, apparently the result of excess dissipation caused by increased leakage at higher junction temperatures and by increased switching time at high values of collector current.

The basic technique, which combines the high gain and linearity of a magnetic amplifier with the high power handling capability of switching transistors, can be applied to various circuit configurations. The resultant amplifiers feature small size, ruggedness, high gain, high power, moderate speed, and linear control of the output. Servo systems, regulated power supplies, and systems for d-c motor and generator field control commonly require amplifiers with these characteristics.

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Centralized Power Control in the Steel Industry

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OPERATING ECONOMIES AND EFFICIENCIES are realized from the concentration of power system control and indication in a single central location. The average steel works power system is ideal for the application of centralized control equipment because of the concentration of substations in a relatively small area. Most existing centralized control of steel works power systems has been provided by supervisory control.

To provide adequate centralized control of a power system, it must be possible to perform all essential control functions at the individual substations from the control center. Likewise, position-indicating lamps must continuously supervise the position of devices involved in the functioning of the substations.

Continuous or selective telemetering of essential quantities must be provided at the control center. Telephone service between the control center and each remote station for emergency communication is essential.

The choice of controls, lamp indications, and quantitative information to be provided is the most important decision made in the application of a centralized control system. It is customary to provide for the control of all circuit breakers in all substations from the control center with the position of all of the circuit breakers being continuously indicated by red and green lamp indications at the control center.

In addition to the lamp indications showing the position of devices controlled or supervised, it is customary to provide lamp indications of various alarm conditions for most efficient operation of the power system. Trouble-detecting devices are often grouped together at the remote substation to provide a common alarm indication if any one of the devices in the group detects trouble. Usual practice provides individual indications for such alarms as substation door, transformer differential lockout, transformer high temperature, or low oil level.

In most telemetered indications, the system operator selects the telemetered indications periodically or as required by means of the centralized control system equipment. Because the distances involved in a steel works are short, the necessary quantitative information is often obtained by connecting the associated potential and current transformers to the cable circuits through auxiliary potential transformers and stepdown current transformers. Voltage and synchronizing indications are the quantities most frequently obtained in this manner. It is usually more economical to obtain other quantitative information by the use of standard telemetering equipment.

For each quantity requiring a continuous indication at the control center, a separate telemetering circuit is necessary. Usually, there are few quantities which must be telemetered continuously, inasmuch as a fast-acting centralized control system can readily provide the operator with any desired indication.

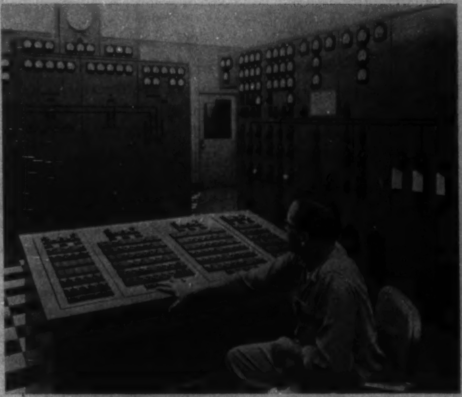

Fig. 1. View of control center at the Fairless Works of the United States Steel Corporation, showing supervisory control desk, system diagram board, and power-station control board.

There are many possible physical arrangements of control-center equipment. Most of the large installations in this country include an electrically operated map or mimic bus arrangement which depicts each device within each substation in its electrical position. The electrically operated map, sometimes called a diagram board, continuously indicates the position of each device under the control of the system operator. Indicating instruments are usually mounted on the diagram board. They can be located in the mimic bus to indicate the exact electrical circuit to which the instrument refers or they can be located on the upper portion of the diagram board.

The diagram board frequently consists of the front panels of a tunnel-type duplex switchboard. A typical installation of this type of construction is shown in the left-hand background of Fig. 1. The right-hand switchboard is the control board for the steel company's own power station. The diagram board and the power station control board are of the same construction, both being tunnel-type duplex switchboards. The diagram board includes only the indicating instruments and indicating lamps. All remote-control operations are performed from the control desk in the foreground.

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Analogue vs Digital Techniques for Engineering Design Problems

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Computer techniques are explained by means of several examples of the types of problems which analogue and digital computers are being called upon to solve. The most important computer characteristics are briefly described.

NEARLY EVERY PROBLEM encountered in engineering at some time proceeds from the qualitative to the quantitative phase where the results of mathematical analysis must be applied in actual computation. Most often the computation is short enough that automatic means are not necessary. However, more and more problems are requiring powerful aids to calculation. This increase is due as much to expanded thinking encouraged by the mere availability of computers as to any actual backlog of work. Therefore, it is to the engineer's advantage to know what computers can do for him, even though he may take his problem to someone else for final preparation and programming.

The following text presents some examples in which automatic calculation is being used. As background for the examples, the most important of these characteristics are presented briefly in the next section.

COMPUTER CHARACTERISTICS

THE MAJOR DIFFERENCES between analogue and digital computers stem from their fundamentally different approach to mathematics. The digital approach permits the use of nothing but the elementary arithmetic operations and yes-or-no decisions, while the analogue approach is one of functional relationships between dependent and independent variables. Any application of computers which varies from this premise does so by making use of additional mathematical formulation. This is borne out historically by the fact that use of analogue computers developed first in engineering and scientific applications which deal mostly with functional equations, whereas wide use of digital computers occurred first in business applications which are concerned with rapid arithmetic operations. With few exceptions, business problems are still limited to digital machines, but more and more engineering problems are being done digitally as more powerful machines become available.

In cases where it is possible to obtain comparable data by analogue or digital computers, the final choice depends on the necessary accuracy, the setup and calculation times associated with the particular computers, the total amount and repetitive nature of the calculation, and the past history and preferences of the personnel involved.

The general-purpose computers used today may be placed roughly in four classes having different computational properties. These are the electric analogue computer composed mostly of passive elements, the electronic differential analyzer using operational amplifiers to perform mathematical operations on analogue voltages, the externally stored program digital machine, and the internally stored program digital machine.

The electronic analogue computer is characterized by its large number of elements, rapid calculation, limited accuracy, and a setup time which is relatively short. The electronic differential analyzer usually has smaller capacity, greater potential accuracy, about the same setup time (not necessarily involving the equipment if prepatch facilities are used), greater flexibility in the treatment of nonlinear functions, and somewhat longer calculation time than the electric analogue computer.

The two digital classes differ primarily in the flexibility of the program, with the internally stored program machine being able to modify its own program as the result of calculation. More through the chronology of development than inherent properties, the externally stored program machine usually has limited number storage and is a slow- or medium-speed machine, while the internally stored program machines range from medium speed and storage to the most powerful computers built. Compared to the analogue machines, some characteristics of digital machines are that they require greater setup time for the initial calculation but less for any subsequent ones from the same program, accuracy limited only by the mathematics involved, simpler handling of arbitrary functions, more awkward formulation of differential equations, and extremely rapid arithmetic.

PROBLEM CHARACTERISTICS

ONE LARGE CLASS of calculations involves straight data conversion by numerical operations, according to fixed rules or formulas. This type of computation is almost certainly done more economically by a digital computer, the type being determined by the magnitude of the problem. At the other end of the spectrum is the large class of problems arising from the transient behavior of control systems. These are handled most easily by electronic differential analyzers because of the direct representation of time differential equations possible on these computers.

Transient behavior of systems involving partial differential equations such as electric power systems or mechan-

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ical structures is best studied on the electric analogue computer because of its large number of elements and the ease of handling the mathematics. This problem could be solved by differential analyzer; but the size of the system would be drastically limited by the size of the computer, inasmuch as approximately one amplifier would be needed for each passive element of the other representation. This problem could also be solved by digital means but only on the most powerful computer and at the expense of much time and effort, since the formulation for numerical solution is extremely lengthy and requires much calculation time compared to the analogue techniques.

Less well defined is the class of static boundary value problems. The electric analogue computer is just as applicable to these as to the transient cases, but now the digital solution appears in a much more favorable light. The decision for analogue or digital computation must be based on more information. If the problem is not expected to occur again later and, especially, if a number of variations are to be calculated at the same time, the short setup and calculation times of the electric analogue make it preferable; but if the problem is expected to recur frequently with only a few cases each time, the short setup time of the digital solution after the initial program has once been written would probably compensate for the longer calculation time. The digital solution may be justifiable initially on the basis of increased accuracy beyond the 1 or 2 per cent of the analogue, but it must be remembered that the digital solution also is only as accurate as the representation.

Another class of calculations which may include elements of the foregoing types and where each case must be examined individually is optimization of design. Depending on the type of calculations performed in the optimization, the decision may be clear-cut; but where either computer is applicable, the ease of parameter variation in the analogue must be weighed against the automatic decision-making features of the digital computer. The frequency with which the problem is encountered is likely to be the deciding factor.

EXAMPLES

Transient Behavior of Mechanical Systems Composed of Coupled Beams. Many mechanical structures of interest to the engineer fall into the general class of coupled beams. Once a preliminary design for a structure has been arrived at, one or more different types of analyses may be necessary to prove the design. Probably, the most difficult data to estimate even by hand methods are the stresses and deflections experienced under the influence of some transient shock.

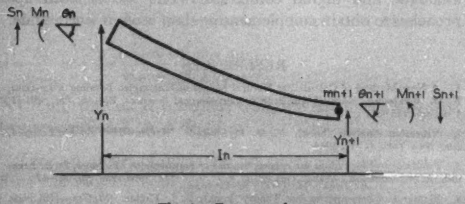


Fig. 1. Beam section.

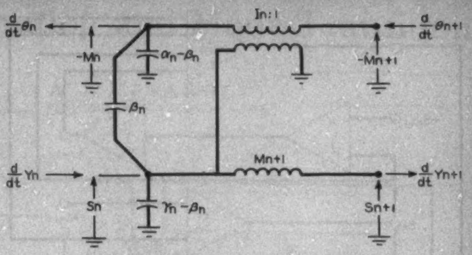


Fig. 2. Passive element analogue.

One approach to simplification of the mathematics is to reduce the partial differential equations to a set of ordinary differential equations by considering the finite difference equations at points along the lengths of the beams. If the mass is considered lumped at discrete points, equations relating the physical quantities at the ends of a section as shown in Fig. 1 may be written as follows:

$$S_{n+1}=S_n-m_{n+1}\frac{d^2}{dt}Y_{n+1} \qquad (1)$$

$$M_{n+1}=M_n+l_nS_n \qquad (2)$$

$$\theta_{n+1}=\theta_n-\alpha_nM_n-\beta_nS_n \qquad (3)$$

$$Y_{n+1}=Y_n-l_n\theta_{n+1}-\beta_nM_n-\gamma_nS_n \qquad (4)$$

where α_n, β_n, γ_n are the elastic coefficients defined by Myklestad,[1] and S, M, θ, and Y are shear, moment, angle, and displacement, respectively.

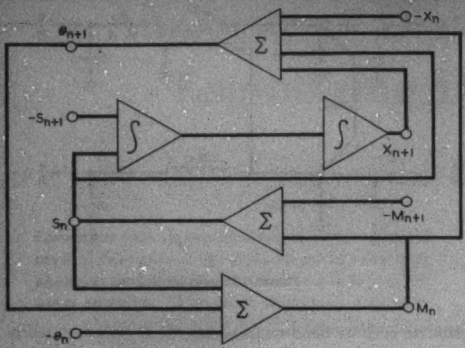
A digital transient solution to the system made up of a number of sets of the equations given is admittedly possible and other approaches may yield an easier digital solution. However, the preparation of a program having sufficient flexibility to handle general problems of this type would be an enormous task.

A number of relatively simple analogues representing equations 1 through 4 are obtainable. Two of these are shown in Figs. 2 and 3. Fig. 2 is a mass-inductance passive-element analogue, while Fig. 3 is an electronic differential analyzer analogue.

These analogues are relatively easy to set up and interconnect to satisfy boundary conditions of complex structures. Though the total number of sections represented is limited by the amount of equipment available and by the accuracy of the elements, the choice of analogue rather than digital equipment is clearly indicated by the ease of handling the mathematics and the associated shorter setup time.

Natural Frequencies of Coupled Beams—Critical Speeds. In a large number of mechanical problems, only the natural frequencies and the stresses associated with them are of primary interest. One such case is the design of turbine-generator rotors where the natural frequencies must not coincide with the running speed or its harmonics.

These frequencies may be obtained from the same



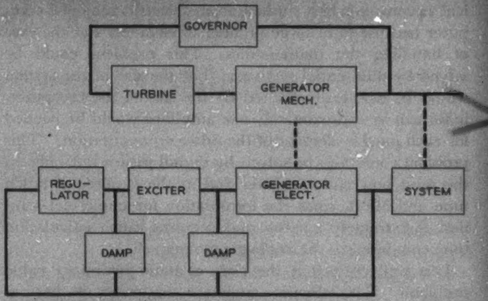


Fig. 3 (left). Operational amplifier analogue. Fig. 4 (above). Generator regulator.

analogues used for transient work; but, in this case, prospects for digital calculation are much brighter. Because the motion of any point in the structure will be sinusoidal with time when a single natural frequency is excited, equation 1 may be rewritten as:

$$S_{n+1}=S_n+m_{n+1}\omega^2 Y_{n+1} \qquad (5)$$

Now equations 2 through 5 may be employed in a calculation of the Holzer type[2] or in a matrix solution to obtain the desired frequencies.

Comparing the essentially constant setup time, limited capacity, and limited accuracy of the analogue solution with the short setup time after the initial programming, unlimited capacity, high accuracy, and smaller chance for error of the digital solution, the choice of digital solution is well defined. The one possible exception to this is a situation where a large number of relatively minor variations are to be examined at one time. In this case, the short solution time may make the passive analogue method the more attractive.

Regulating Systems. The regulation of the voltage of a turbine generator is a representative example of a complex feedback control system. Fig. 4 is a block diagram of the regulating system and is presented to illustrate the complexity of the problem.

The straightforward approach to most regulating systems is provided by the electronic differential analyzer.[3] This problem is no exception in that the differential analyzer will provide the most data on the transient response with the least effort. However, with systems of this complexity it is often difficult to foresee the best approach to system modification when the analogue indicates an unacceptable solution. Some additional information, or some better evaluation of the same information, is often found to be desirable.

A digital approach to transient response based strictly on the solution of the differential equations would not yield anything new and, in addition, would be more difficult than the analogue solution. However, the information supplied by phase-gain analysis, while it does not yield accurate transient data, is quite useful for qualitative prediction. A digital computer is admirably suited to the computation of this type of data, whereas phase measurements from an analogue are not altogether satisfactory.

The obvious conclusion, and the one which this example was meant to bring out, is that there are some problems where analogue and digital machines can work together profitably.

CONCLUSIONS

1. Provided that an analogue can be devised, transient problems involving partial differential equations are best handled on a passive-element electric analogue computer. The electronic differential analyzer is less satisfactory because of capacity limitations but offers some compensation in handling nonlinearities.
2. Transient and control problems based upon ordinary time differential equations are most easily handled by electronic differential analyzer. However, a digital solution is feasible and may be indicated by a repetitive problem involving highly nonlinear functions.
3. Most static boundary value and quasi-steady-state oscillatory problems may be solved nearly equally well by either analogue or digital means. Low frequency of occurrence and many minor parameter variations indicate use of analogue equipment. Repetitive setup and extreme accuracy and capacity requirements indicate use of digital computers.
4. Data reduction problems and economic optimization based on a choice of functionally similar designs are best handled digitally.
5. A large number of calculations, primarily performance calculations, may be approached by different paths on analogue and digital computers. The use of both approaches to obtain complementing data is often worthwhile.

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Simple Reactor Circuit Operation and Mode Transition

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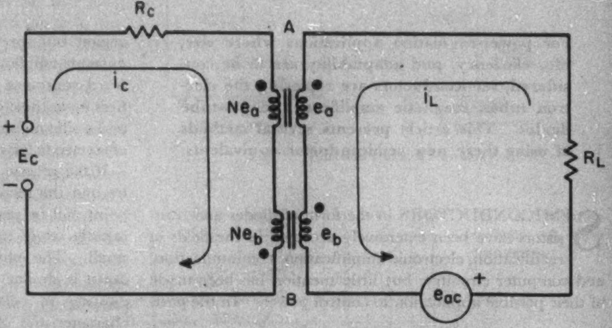

Fig. 1. **The series-connected simple saturable reactor circuit.**

METHODS for designing simple saturable-reactor magnetic amplifiers and predicting their performance on the basis of observed phenomena have been known for some time. However, the literature in the field is still lacking a complete analysis of saturable-reactor circuitry on the basis of the mechanics of operation. This analysis utilizes the volt-second approach developed by R. A. Ramey[1] to analyze completely the simple series saturable-reactor circuit in both its transient and steady states.

The simple reactor circuit is complex to analyze. An analysis, based on nonideal flux current loops, leads to involved mathematical expressions which tend to obscure the mechanics of operation. Similarly, an analysis considering ideal loops will also obscure the concept of operation if sine-wave excitation and constant d-c control are used as forcing functions.

However, if an ideal flux-current loop is assumed and a square-wave supply voltage is considered in conjunction with a constant amplitude d-c control voltage, the mechanics of operation may be clearly described.

Fig. 1 shows the actual circuit which is analyzed. The analysis as presented is based upon period equations. Each half cycle of the supply voltage is divided into periods, a conducting and a nonconducting period. For each period, enough is known to allow for the derivation of equations for load current, control current, and voltages across the reactors. From these equations, expressions describing the transient and steady-state circuit operation are derived.

Two distinct modes of operation of the amplifier exist. Circuit classifications corresponding to these two modes have previously been described as high control-circuit impedance and low control-circuit impedance.[2] However, the mode in which the amplifier is operating is not directly a function of the magnitude of the control circuit resistance but is directly dependent upon the relative magnitudes of the control and supply voltages.

A relation of these two voltages is defined as A, where

$$A=\frac{E_c}{NE_{ac}} \text{ and } N=\frac{\text{control winding turns}}{\text{load winding turns}}$$

A circuit constant K is defined from the circuit parameters by the equation $K = N^2R_L/R_C$.

The two modes of operation are physically distinguished from one another by the circuit currents. If a nonconducting period (i.e., period of zero load and control current) exists during any portion of each half cycle, the amplifier is operating in mode 1. If no nonconducting period exists, the operation is in mode 2. The amplifier may operate only in mode 1 when $A < 1$ and only in mode 2 when $A > 1$, provided that full output has not been reached. A given circuit will have an associated constant K, peculiar to that circuit. The product AK determines the fraction of full output which is achieved for a given control voltage and full output results when $AK = 1$.

A transient equation is developed for each mode of operation showing the average output of the amplifier in an nth half cycle as a function of the steady-state output, the constants A and K, and the number of half cycles n which have passed. In mode 1 the average load current in the nth half cycle is given by the equation

$$I_{L,n,avg}=\frac{NE_c}{R_c}\left[1-\frac{K}{K+1}\left(\frac{K-1}{K+1}\right)^{n-1}\right] \tag{1}$$

In mode 2, the average load current in the nth half cycle is given by the equation

$$I_{L,n,avg}=\frac{NE_c}{R_c}\left[1-\frac{K(A^2K+1)}{A(K+1)(AK+1)}\left(\frac{AK-1}{AK+1}\right)^{n-1}\right] \tag{2}$$

If the term A in equation 2 is decreased to unity, this mode 2 equation is seen to degenerate into equation 1, indicating a smooth transition from mode to mode.

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Power Regulation by Semiconductors

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For power-regulation applications where size, life, efficiency, and adaptability are to be considered, semiconductors are replacing the electron tubes, magnetic amplifiers, and gas-tube diodes. This article presents several methods of using these new semiconductor equivalents.

SEMICONDUCTORS in the form of diodes and transistors have been extensively accepted in the fields of rectification, electronic amplification, communication, and computer circuitry, but little mention has been made of their possible application to control power. In the past, electron tubes, magnetic amplifiers, and gas-tube diodes have been employed for this purpose. This article illustrates some of the methods of using their semiconductor equivalents—particularly those that apply to the regulation of direct potentials and currents.

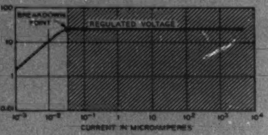

Fig. 1. Silicon junction diode characteristics.

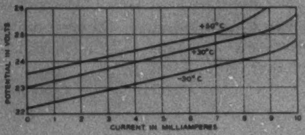

Fig. 2. Silicon junction diode regulated voltage characteristics.

Two types of devices are required in power regulating circuits: a constant reference voltage for comparison, and a circuit element having controllable characteristics. In semiconductor regulating circuits, silicon junction diodes provide the reference potentials and junction transistors are the controllable elements. Before circuits are discussed, however, it might be advantageous to review pertinent characteristics of these devices.

SILICON JUNCTION DIODES

A SILICON JUNCTION DIODE is a *p-n* junction device made from very pure silicon with small amounts of selected impurities added to obtain the *p* and *n* regions. It will conduct current very easily from the *p* region toward the *n* region but, in its normal operating range, only minute currents will flow from *n* toward *p*. Thus, it has a low forward resistance and a high reverse resistance. All rectifiers have these characteristics to a greater or lesser degree, and a silicon junction diode is classified by a very high ratio of reverse to forward resistance.

If the reverse current through such a diode is increased beyond the rectifying range, a nondestructive breakdown point will be reached, where the current will increase very rapidly while the change in potential drop remains very small. The physical process responsible for this breakdown is similar to the ionization that causes the familiar glowing in cold-cathode gas-filled tubes. In fact, the characteristics of a silicon junction diode beyond breakdown are very similar to the sustaining characteristic of these tubes, Fig. 1. However, the breakdown potential of silicon junction diodes can be controlled during manufacture from about 4 to 1,000 volts. This can be compared to the 60–150 volt range of voltage-regulator tubes.

To show the wide range of current where there is a substantially constant voltage drop, Fig. 1 is plotted to a logarithmic scale. The stability of this diode in its regulated voltage region is shown in Fig. 2 by redrawing a small section of Fig. 1 using a linear scale, and two additional curves show the effect of ambient temperatures. The slope of the +30 C temperature curve is equivalent to a resistance of 250 ohms in series with a 23-volt battery, when current flows through this combination from an external source. The change of potential with ambient temperature is equivalent to a 0.07 per cent change per degree centigrade. It should not be inferred that these are minimum values—6-volt diodes have been tested that exhibit slopes of less than 10 ohms and temperature coefficients of less than 0.01 per cent per degree centigrade. Several manufacturers are now in position to supply these diodes.

JUNCTION TRANSISTORS

IN A JUNCTION TRANSISTOR, two *p-n* junction rectifiers are contained in a bar, cut from a single crystal of germanium or silicon. These two rectifiers are produced by interposing a wafer of *p*-type material between two sections of *n* type, making an *n-p-n* transistor, or interposing a wafer of *n* type between two sections of *p* type, making a *p-n-p* transistor. Electrical connections to the ends of the crystal are called the collector and the emitter, with the connection to the wafer called the base. With either of these transistors, there is a *p-n* junction rectifier between collector and base, and another *p-n* junction rectifier between the emitter and base. The polarity of these two rectifiers is reversed in the two types of transistors, as shown in Fig. 3.

If a potential E_c is connected to the collector and emitter terminals as shown in Fig. 3, current will flow through the

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F. H. Chase is with Bell Telephone Laboratories, Murray Hill, N. J.

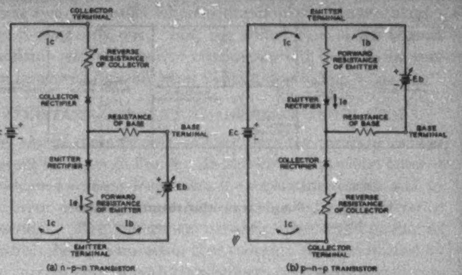

Fig. 3. **Junction transistor analogy.**

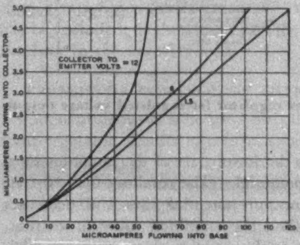

Fig. 4. **Characteristics of *n-p-n* transistors.**

collector and emitter rectifiers in series. These rectifiers are so poled that current flows through the collector rectifier in its reverse direction, and through the emitter rectifier in its forward direction. Now, when a second potential *Eb* is connected between base and emitter, the resulting control current flows through the emitter rectifier in its forward direction, and the collector current increases. This increase in collector current is proportional to the amount of base current, but is many times larger. This is current amplification. Both types of transistors are current amplifiers, and since the potentials and currents are reversed in the two types, they have "reversed symmetry."

No attempt will be made to explain why this current amplification takes place. Several books and many technical articles have been published covering the solid-state physics involved. For present purposes, it is only necessary to measure the static characteristics of a transistor to prove that amplification really occurs. These characteristics for a germanium *n-p-n* transistor, measured in the "grounded-emitter" circuit of Fig. 3, are shown in Fig. 4. Grounded-emitter d-c amplifiers are used in the regulator circuits described in this article.

Referring to Fig. 4, in the straight portion of the 1.5-volt curve, a change in base current of 50 microamperes will result in a change of 2 milliamperes in collector current. If the base current is considered the input to an amplifier circuit and the collector current the output, this transistor will have a current amplification of 40. Naturally, other transistors have different values of current amplification. All manufacturers rate the current gain of their transistors in terms of α, as measured under specified conditions, in a grounded-base circuit. The definition of α is such that the current amplification, in a grounded-emitter circuit, is α divided by 1-α. The transistor used for these measurements had an α of 0.976, and therefore 40.7 should be its current gain; this is in reasonable agreement with the curves. The curvature of the 12-volt characteristic is caused by the power dissipation heating the transistor.

Again referring to Fig. 4, it will be seen that transistors will operate at very low collector potentials; 1.5-volts is not the minimum potential at which this particular transistor will operate. Some transistors have good current amplification at potentials as low as 0.2 volt.

When the base current is reversed, the characteristics in Fig. 4 can be extended to still smaller collector currents. It might be assumed that the collector current could be reduced to zero; this is not true. There is a minimum collector current and making the base more negative with respect to the emitter will not decrease it below this value. This collector cutoff current, assigned the symbol I_{co}, is usually a few microamperes, but it doubles for each increase of 10 or 12 C in ambient temperature. Most manufacturers rate their transistors for maximum I_{co} current under specified testing conditions.

Reviewing the above characteristics of junction transistors, there are two types—*n-p-n* and *p-n-p*, with reversed symmetry. Each will amplify current changes in its base circuit into much larger current changes in its collector circuit. The reversed symmetry of these two types of transistors does not occur in electron tubes because no tube will operate with a negative plate potential. This reversed symmetry will be used to advantage in power regulating circuits.

TRANSISTOR SHUNT REGULATORS

A SHUNT REGULATOR is a circuit in which a shunt element draws variable current through a resistor, that also is in series with the load. If the load requirement increases, the shunt element draws less current; if the load decreases, the shunt element draws more current. The net result is a practically constant output voltage. A familiar example of this type of regulation is the use of a voltage-regulator tube. Here, the output voltage is the same as the sustaining voltage of the tube. A silicon junction diode operating in its regulated potential region is the semiconductor equivalent of this voltage regulator tube, and it can be used in exactly the same way to provide a constant-voltage output. Unfortunately, the regulated potential is the nonadjustable breakdown voltage of the diode. However, Fig. 5 shows a transistor shunt regulator in which the output potential can be adjusted.

In this circuit, an *n-p-n* transistor is used as a current amplifier. Its emitter current flows through a silicon junction diode in the reverse direction, thus providing a regulated voltage drop to be used as a reference potential. For convenience, this diode is called a "diode potential standard" on all figures where it is used for this purpose. Variations in the output voltage are impressed on the base of the transistor through the potentiometer, which is adjusted so that the base is slightly positive with respect to the emitter. The base-to-emitter potential is then that portion of the

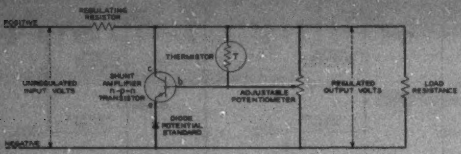
REGULATING RESISTOR
POSITIVE
THERMISTOR
T
c
SHUNT AMPLIFIER n-p-n TRANSISTOR
b
e
UNREGULATED INPUT VOLTS
ADJUSTABLE POTENTIOMETER
REGULATED OUTPUT VOLTS
LOAD RESISTANCE
DIODE POTENTIAL STANDARD
NEGATIVE

Fig. 5. Simple transistor shunt regulator.

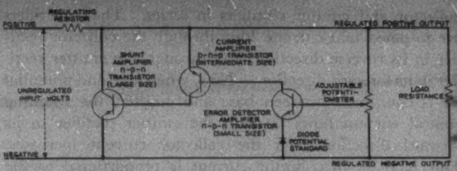
REGULATING RESISTOR
POSITIVE
REGULATED POSITIVE OUTPUT
CURRENT AMPLIFIER p-n-p TRANSISTOR (INTERMEDIATE SIZE)
SHUNT AMPLIFIER n-p-n TRANSISTOR (LARGE SIZE)
UNREGULATED INPUT VOLTS
ADJUSTABLE POTENTI-OMETER
LOAD RESISTANCE
ERROR DETECTOR AMPLIFIER n-p-n TRANSISTOR (SMALL SIZE)
DIODE POTENTIAL STANDARD
NEGATIVE
REGULATED NEGATIVE OUTPUT

Fig. 6. Three-transistor shunt regulator.

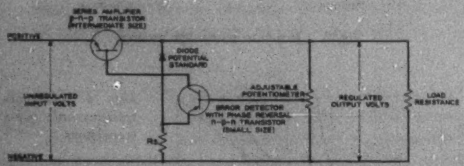
SERIES AMPLIFIER p-n-p TRANSISTOR (INTERMEDIATE SIZE)
POSITIVE
DIODE POTENTIAL STANDARD
UNREGULATED INPUT VOLTS
ADJUSTABLE POTENTIOMETER
ERROR DETECTOR WITH PHASE REVERSAL n-p-n TRANSISTOR (SMALL SIZE)
REGULATED OUTPUT VOLTS
LOAD RESISTANCE
Rs
NEGATIVE

Fig. 7. Transistor series regulator for regulated voltage output.

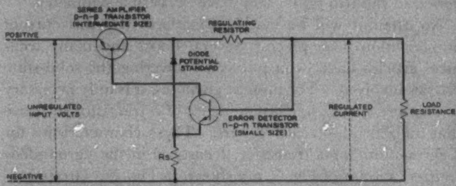
SERIES AMPLIFIER p-n-p TRANSISTOR (INTERMEDIATE SIZE)
REGULATING RESISTOR
POSITIVE
DIODE POTENTIAL STANDARD
UNREGULATED INPUT VOLTS
ERROR DETECTOR n-p-n TRANSISTOR (SMALL SIZE)
REGULATED CURRENT
LOAD RESISTANCE
Rs
NEGATIVE

Fig. 8. Transistor series regulator for regulated current output.

output voltage across the lower part of the potentiometer, minus the reference potential. The resulting base current increases when the output potential rises and decreases when it falls, controlling the amplified collector current. This collector current is the variable shunt current which changes the voltage drop across the series resistor to regulate the output potential.

Since all changes in the shunt regulating current—the collector current, plus the base current—flow through the diode, the transistor in Fig. 5 does not improve the regulation. It does, however, provide a method of adjusting the regulated output, by means of the potentiometer, to a voltage greater than the reference potential. In a practical shunt regulator, the adjustment of the potentiometer would be limited by the operating range of the transistor, from its uncontrollable I_{co} current to its maximum allowable wattage dissipation value. It is usually desirable to provide a minimum collector current which is several times the I_{co} current to reduce the effect of ambient temperatures on the output voltage.

Fig. 5 also shows a method of compensating for ambient temperature variations. If a properly chosen thermistor is connected across the upper part of the potentiometer, its resistance change with temperature will counteract temperature changes in the diode and transistor, maintaining a constant output potential. This method of temperature correction is not shown on succeeding figures because it is not required for many applications, but it can be used in any of these circuits.

In Fig. 6, two current amplifiers have been added to the shunt circuit to improve regulation. The transistor that compares the output voltage to the reference potential is now called an "error detector." Except for the collector connection, its circuit is identical with that of Fig. 5. However, collector current in the *n-p-n* error detector is also the base current of the *p-n-p* current amplifier. This series connection provides current amplification in both transistors. Because of their reversed symmetry, the direction of collector current in an *n-p-n* transistor is the same as the base current in a *p-n-p* transistor.

A similar series connection is used between the collector of the *p-n-p* transistor and the base of the *n-p-n* shunt amplifier. This transistor is called a "shunt amplifier" because its collector current, flowing through the regulating resistor, contributes the largest part of the variable shunt current that regulates the output voltage. Now, base current flowing into the error detector is amplified by its current gain, amplified again by the *p-n-p* transistor, and amplified a third time by the shunt transistor to obtain the shunt current. The total amplification is, for all practical purposes, equal to the product of the current gains in each of these transistors. Fig. 6 is a better regulator than Fig. 5 because of this added amplification, and because only a small fraction of the shunt-current variations flow through the diode.

In Fig. 6, different sizes are specified for the three transistors. The small *n-p-n* transistor shown for the error detector might be one that will safely carry 5 milliamperes collector current. Then the maximum base current of the *p-n-p* transistor should not exceed 5 milliamperes and, with an assumed current amplification of 20, its maximum collector current could be 100 milliamperes. Such a transistor is now available as a commercial product. With 100 milliamperes flowing into the base of the large *n-p-n* shunt transistor, and a current amplification of 20, it would have a maximum of 2 amperes shunt current. Two amperes of shunt current will regulate a small-sized load but, as far as is known, transistors handling this amount of current at a reasonable voltage are not yet commercially available.

The circuits of Figs. 5 and 6 can be modified to use the reversed types of transistors. These modifications are useful when the desired components are available in one type and not in the other. They can also be used when necessary to insert the regulating resistor in the negative lead.

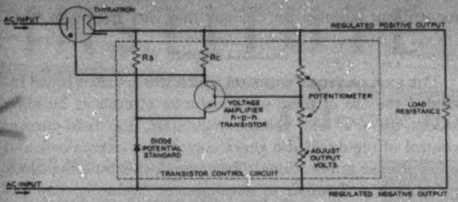
THYRATRON
AC INPUT
REGULATED POSITIVE OUTPUT
Rs
Rc
POTENTIOMETER
VOLTAGE AMPLIFIER n-p-n TRANSISTOR
LOAD RESISTANCE
DIODE POTENTIAL STANDARD
ADJUST OUTPUT VOLTS
TRANSISTOR CONTROL CIRCUIT
AC INPUT
REGULATED NEGATIVE OUTPUT

Fig. 9. Transistor regulated thyratron-tube rectifier.

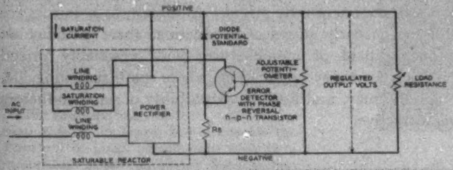

Fig. 10. Transistor regulated saturable-reactor rectifier.

TRANSISTOR SERIES REGULATORS

Variable shunt-current circuits are good voltage regulators, but series regulators are usually more efficient. A shunt regulator wastes its shunt current, plus the voltage drop across its regulating resistor, whereas a series regulator wastes the voltage drop across its series device, plus a much smaller amount of control current. Under light loads, the power dissipated in a shunt circuit is greater than that in a well-designed series regulator. With a transistor as the series element, this difference in efficiency is more pronounced because of the small emitter-to-collector potential that can be used. This is the voltage drop across the series transistor, Fig. 7.

Fig. 7 is a simple series regulator similar to Fig. 6, with the *p-n-p* transistor in series with the load so that its collector current is the load current. Comparison of the output voltage with the reference potential in the error detector is the reverse of that used in Figs. 5 and 6. The emitter is held at a fixed potential with respect to the positive rather than the negative output. This change in the reference voltage connection results in a phase reversal of the base and collector-current variations. With the potentiometer adjusted so that the base is slightly positive with respect to the emitter, as before, the base-to-emitter potential, base current, and collector current all decrease when the output voltage increases. This collector current, multiplied by the current gain of the *p-n-p* series transistor, decreases the load current, reduces the output voltage, and thus regulates it. Resistor *Rs* limits the current through the diode to its regulated potential range; the potentiometer adjusts the output voltage.

In Fig. 7, the series amplifier is inserted in the positive lead; this circuit can be modified to place it in the negative lead by using reversed-type transistors. This flexibility is not possible with electron-tube series regulator circuits. The simplest form of transistor series regulator, Fig. 7, requires two transistors whereas the simplest shunt regulator, Fig. 5, uses only one. But, the added gain of the second transistor results in better regulation, and this can be further improved by additional transistors as in Fig. 6.

CONSTANT-CURRENT TRANSISTOR REGULATORS

A series circuit that will regulate for constant output current is shown in Fig. 8. In this circuit, the load current produces a voltage drop across the regulating resistor and, in the error detector, this voltage is compared to the reference potential. The difference between these two potentials controls the *n-p-n* transistor base current; this is amplified by the current gain of both transistors to produce the load current. The circuit is so phased that the load current will increase when it is too small and decrease when too large. The regulated value of load current can be adjusted by using a variable regulating resistor. Additional transistors may be included, or the circuit modified to insert the series transistor in the negative lead.

TRANSISTOR CONTROL OF THYRATRON TUBES

Semiconductors can be used directly in either series or shunt regulator circuits to control small amounts of direct current. However, with transistors now available, only moderate voltages and currents can be regulated in this manner. Where higher power output is required, it is expedient to combine these circuits with other devices.

Fig. 9 shows an *n-p-n* transistor used as a voltage amplifier with a magnitude-controlled thyratron-tube rectifier. Comparison of the output and reference voltages is the same as in Fig. 5, and an increase of output potential will result in an increase of collector current. This current flows through resistor *Rc* and the resulting voltage drop provides a negative grid potential for the thyratron tube, to control its firing point. An increase in output voltage will delay firing of the tube until later in its conducting half cycle, to regulate the output. Good regulation of a full-wave 24-volt 8-ampere rectifier has been obtained with this circuit.

TRANSISTOR CONTROL OF SATURABLE REACTORS

Transistor circuits may also be combined with magnetic-amplifier devices to regulate still higher power outputs. This combination is useful for applications where a high-speed response is not required, since it will regulate several kilowatts. Fig. 10 illustrates a constant-voltage regulated rectifier; a similar circuit will regulate for constant current.

The transistor circuit in Fig. 10 is very similar to the error detector in Fig. 7. Comparison of the output and reference potentials is identical as the phase reversal of base- and collector-current variations. Collector current flows through the saturation winding of a 3-winding saturable reactor; the phase reversal decreases the saturation current whenever the output voltage increases. In the reactor, decreased saturation current produces a decreased alternating voltage at the rectifier input, regulating the output potential. A change in output voltage does not instantaneously produce a change in saturation current; this is characteristic of all magnetic-amplifier regulating circuits. Delay in the transistor is comparatively small, and can usually be neglected.

Additional amplification to improve regulation can be added to Fig. 10 in two ways: transistor current-amplifier stages can be added or magnetic-amplifier stages can be used. Additional magnetic amplifiers will further lower the speed of response; the delay of several transistors is negligible. A saturable reactor regulated rectifier with constant output current can be obtained by using the error-detector circuit of Fig. 8 in place of the error-detector circuit in Fig. 10.

A 2-stage push–pull modification of the transistor circuit in Fig. 10 has been used to regulate a 3-phase 50-volt 200-ampere rectifier with very good results. It uses six germanium junction diodes with forced-air cooling for the power rectifier and six high-gain self-saturating magnetic amplifiers controlled by the 2-stage transistor circuit. Output voltage variations are less than 0.5 volt, from 0 to 200 amperes output load, for a 20 per cent (± 10 per cent) change in a-c input potential. These variations are also less than 0.5 volt for ambient temperature changes that vary from 0 to 40 C.

CONCLUSIONS

THE EXPLORATORY WORK on which this article is based included the use of these semiconductor circuits as building blocks for a-c line voltage regulators, for field-current control of regulated d-c generators or a-c alternators, and other similar applications. In general, this building-block circuitry is so familiar to development engineers that further illustrations would be redundant.

Of course, commercial use of transistors and diodes for this purpose depends upon their availability, in the proper types, at commensurate prices. Although these devices are still in the early stages of production, there is today an adequate field of manufactured and reasonably priced products for many applications where small size, long life, high efficiency, and flexible adaptability of semiconductors are attractive.

Combat Helmet Radio Designed by Signal Corp

Forward scout at Fort Monmouth, N. J., reports back to his squad through the world's smallest combat radio, which is built into his helmet. He talks into a thumb-sized microphone that slips easily under the helmet when not in use. The radio weighs less than a pound, including batteries. In actual combat, this GI would be safer than most forward observers, who have to carry radios on their shoulders, impeding their movement and making them easy to spot as radiomen—priority targets.

The Army Signal Corps recently unveiled a combat helmet radio that lets GI's talk to each other—through their hats. It was developed by the Signal Corps Engineering Laboratories at Fort Monmouth, N. J., to bring walkie-talkie communications to the individual rifleman.

The experimental helmet, which looks like a football player's headgear, contains the smallest known two-way military radio. The set was made smaller than two packs of cigarettes by use of transistors. It operates continuously for a half-day on a single set of tiny batteries.

To prevent enemy interception of messages at the front lines, the helmet radio is preset for short-range conversations between squad members. But at a moment's notice, range can be greatly increased by attaching an auxiliary antenna to the top of the helmet. At full capacity, the helmet can reach radios up to a mile away, and can hear powerful stations at even greater distances.

To answer a call, the soldier merely flips a switch and talks into a microphone about the size of his thumb. No warm-up time is needed—the set's transistors act instantly. When talking might give away his position, the GI can push a second button at the side of the helmet, and acknowledge a message with a short radio "beep." To send this signal, the soldier looks as if he were scratching his head, but he is really saying "Roger."

One possible military application of the helmet might be to provide radio communications for every member of special combat units. A GI in such a unit would hear at once when plans are changed. He could warn a buddy of snipers, minefields, or other dangers.

The new radio is going through a round of exhaustive tests at Fort Monmouth and is soon to enter limited trial production. Low-cost automatic-assembly techniques may allow its rapid mass production. Assembly-line models are expected to be practically indestructible.

INSTITUTE ACTIVITIES

A Message from the President

To All Members of the Institute:

It is with sincere regret that I must extend my personal greetings to most of you in this manner, but they are just as genuine as though they were transmitted with a firm and friendly handshake. Then, too, I want to express my deep appreciation for the honor that you have conferred upon me and for the confidence that you have expressed in my ability to assist in guiding the Institute through the next administrative year.

Our Institute has grown to such proportions that it no longer is possible for the President to make official visits even to a reasonable proportion of the Sections and Branches as in early years. The record now indicates 109 Sections, 61 Subsections, and 143 Branches. However, each general meeting and each district meeting does give opportunity to make many new acquaintances in addition to enjoying the many wonderful friendships made over the years. I cherish both experiences and look forward with pleasant anticipation to those occasions and opportunities. If any one trait characterizes the AIEE, it is the progressive friendly spirit that permeates throughout its length and breadth.

M. S. Coover

Presidential Visitations

With so many new members coming into the Institute within the past few years, it may be worth taking a moment to learn of at least one way in which we try to take our Institute out to the individual member. To offset the physical impossibility of presidential visitations, the Board of Directors deliberated for several years on how to release the President of responsibility for Section visits, and to place this responsibility upon the Vice-Presidents. A resolution to this effect was adopted on June 27, 1946, and appears on pages 608–9 of the 1954 Year Book.

Since then, our Vice-Presidents and other officers of the Institute have really been bringing the Institute to the members. It is their intent to be of greatest possible service to Sections, Branches, and technical groups. They are devoted to the task of aiding Section and Branch officers in the more effective handling of their respective groups.

My own interest in the AIEE began to germinate when I joined the Student Branch at my Alma Mater. It was stimulated following graduation through attendance at meetings of the New York Section where I had the pleasure of seeing and hearing in person many of the leaders of those days in the field of electrical engineering. In time, the opportunity came to participate in committee work and with that came an ever increasing interest in the aims and objectives of the Institute, and that leads me into an area of some of our current activities.

Reorganization for Administration

The electrical industry continues to expand as everyone knows. The AIEE is representative of the total electrical industry in one way or another. It is in position to continue to act as spokesman for this ever important industry that is so necessary to our national well being. The Institute is constantly attempting to upgrade its professional, technological, and educational activities. Indicative in part is the announcement on page 644 of the July 1956 issue of *Electrical Engineering* of the approval by our Board of Directors of a new technical division of AIEE to be known as the Instrumentation Division. However, more significantly representative of attempts to keep the Institute attuned to progress in the three broad areas mentioned above is a major reorganization of the Institute structure that was approved by our Board of Directors at the Summer and Pacific General Meeting. New problems in Institute administration are involved in the reorganization, but it is confidently believed that they are all capable of satisfactory resolution in the direction of progress. The organization chart (pages 857–9) represents the new venture at the national level. Every member of the Institute should give enough attention to the chart to become familiar with it. This applies particularly to all Institute officers at all levels, all members of general committees, technical committees, and subcommittees, also to all members of the Institute who aspire to more active participation of any kind in Institute affairs. The way has been opened for new explorations in Institute administration that will determine whether there are new and better ways to serve our membership and the profession.

Looking Ahead

The 1956–57 administrative year of the Institute presents many challenges that are broad scope, some incapable of complete resolution within the year, as for example, attainment of unity of professions. However, all are inspiring, stimulating, and I have every confidence that some progress can be made. Active participation in Institute affairs is a rewarding experience. I cordially invite all of you to join with me in helping to further the objectives of our Institute so that we may continue to serve society at large in increasing useful measure.

Most sincerely,

M. S. COOVER
President, AIEE

AIEE Fall General Meeting To Be Held October 1–5, 1956

THE THEME of this year's AIEE Fall General Meeting will be the Nikola Tesla Centennial. At the meeting, which will be held October 1–5, at the Morrison Hotel, Chicago, Ill., Dr. S. G. Hibben will present a demonstration-type lecture commemorating Dr. Tesla's outstanding contributions to the electrical industry and to the world. He will speak chiefly on the aspects of Tesla's work that relate to high-frequency studies connected with radiation or luminous phenomena.

Several spectacular high-voltage and illumination demonstrations are promised. Dr. Hibben, formerly director of applied lighting, Lamp Division of Westinghouse Electric Corporation, is now an engineering consultant specializing in illumination.

On Thursday, October 4, 1956, Dr. C. F. Kettering will be honored at a luncheon in the Terrace Casino of the Hotel Morrison to celebrate his 80th birthday. All members of the engineering profession are invited to pay tribute to his many accomplishments, not only in electrical engineering, but also in the automotive and mechanical fields.

Because of its central location, Chicago, Ill., is easily accessible by air, rail, and automobile. Its widely diversified industries make the city an ideal spot for this meeting.

Technical Sessions

The 54 technical sessions are planned to cover the electrical industry as broadly as possible. They include: rotating machinery, protective devices, metallic rectifiers, chemical industry, electric welding, land transportation, safety, transformers, insulated conductors, dielectrics, industrial power systems, switchgear, telegraph systems, mining and metals, feedback control systems, system engineering, education, instruments and measurements, radio communication, communications maintenance, transmission and distribution, ethics, power generation, computing devices, television and aural broadcasting, industrial control, petroleum industry, communication theory, basic sciences, wire communications systems, and electronics.

The Management Committee is planning a panel discussion by several young graduate engineers (five or six years out of college) who work and were trained in the Chicago, Ill., area in various industries. These men will discuss their preparations for their work, the training they have received on their jobs, and the opportunities which have been presented to them.

The Communications Division will sponsor two sessions on Friday, October 5, at the Fall General Meeting, covering an interchange of philosophy, goals, methods, and results of electronic equipment maintenance. Viewpoints of the manufacturers, the layout engineer, and the user will be covered in six papers especially prepared for these sessions. An objective of these sessions is to lay the groundwork for a Special Technical Conference, to be held at a later date, covering more specific maintenance problems and procedures. Participation in these sessions is expected from the Carrier Current Committee, as well as other interested groups such as the American Association of Railroads and the U. S. Independent Telephone Association.

Electronics Conference

All AIEE members are invited to attend the 12th Annual National Electronics Conference (NEC), October 1–3 at the Hotel Sherman in Chicago, Ill. There will be more than 100 technical papers and 240 exhibits. Electronic technical sessions at the AIEE meeting will be held after the NEC closing date so that AIEE members interested in electronics can reap full benefit from both meetings.

Come Early for Reception

A relaxing time is promised those who come early to avoid the rush. A Get-Acquainted Tea and Hospitality Hour will be held on Sunday, September 30, in the hotel. This informal event lasts from 4 to 6 p.m., and is sponsored jointly by the Fall General Committee and the Chicago Section of AIEE.

Ladies Program

An interesting program for the ladies attending the meeting has been planned by Mrs. F. A. Larson and her committee. On Monday afternoon, the ladies will meet in the Walnut Room of the hotel for bridge, or canasta, and tea. This event is held through the courtesy of Allis-Chalmers Manufacturing Company.

On Tuesday at 11 a.m., General Electric Company has cordially invited the ladies to attend a delightful program presented by Mrs. Purdie Meissner, one of the foremost monologists in the midwest. She has promised highlights from a new Broadway play. After the program, luncheon will be served. The program and luncheon will be held in the library of the Furniture Club of America, overlooking Lake Michigan.

Wednesday is reserved for shopping, and tours of some of Chicago's most interesting attractions. Among them are the Art Institute of Chicago, the Field Museum, the Adler Planetarium, the new Prudential Building, etc. Guests are invited to name the place they would like to visit, and small tours will be organized by the hostesses.

On Thursday noon, the committee has planned a luncheon at the Merchant's and Manufacturer's Club in the Merchandise Mart, followed by a tour of many of the Mart's home furnishings show rooms and NBC's new color studio while a program is in progress.

The Merchandise Mart, nicknamed "The City within a City," is internationally known as the world's biggest wholesale buying center. The tour will offer a fascinating glimpse of home fashions of the future. Tickets for this event are $4.50. Send reservations to Mrs. F. A. Larson, chairman, Ladies Committee, 323 Meota St., Park Forest, Ill.

Each morning, from 9:00 to 10:30, coffee and rolls will be served in Ladies' Headquarters. Hostesses will be in attendance to explain each day's program, and to help guests plan the day's entertainment.

Fall Frolics

The committee is taking last year's Smoker, adding dancing, and, they hope, all the members' beautiful wives at each and every table, and calling it the Fall Frolics. This colossal affair is scheduled for Wednesday night, October 3. There will be a small group of musicians playing when guests arrive in the Terrace Casino and they will continue playing while everyone enjoys an excellent dinner. An unusual show for after-dinner entertainment is planned. Afterwards there will be music for dancing or listening pleasure. Dress will be informal. Tickets are $10 each. Order Fall Frolics tickets now by sending order and money to: D. H. Beal, chairman, Fall Frolics Committee, Room 1201, Illinois Bell Telehpone Company, 208 West Washington Street, Chicago 6, Ill.

Hotel Reservations

A sufficient number of rooms have been set aside at the Morrison Hotel, Madison and Clark Streets, to accommodate all those planning to attend the meeting.

Rates per day at the Morrison Hotel are: single room (one person), $6–$12.50; double room—double bed (two persons), $9.50–$16; double room—twin beds (two persons), $13.50–$16; two room suite—parlor, bedroom, $27–$41. All rooms are with bath, Servidor, and ice water.

For the convenience of those expecting to attend the meeting, an advance room reservation card will be enclosed with mailed announcements. It is suggested that this be mailed by September 20 to insure accommodations. If this card is misplaced, a request by letter to the Morrison Hotel should mention that the reservation is in connection with AIEE.

As the first week in October will be a full one for all Chicago hotels, those planning to arrive at the Morrison after 6 p.m., who want to make sure they will have sleeping accommodations, must make a deposit of $5 for a single room and $10 for a double room. This will be refunded if the room cannot be used and the Morrison is notified in time.

If assistance is needed in obtaining a room, members should contact R. S. Roeing, Hotel Arrangements Committee, C. E. Niehoff and Company, 4925 Lawrence Ave., Chicago 30, Ill.

Inspection Trips

A number of varied and interesting inspection trips are planned for the week of the meeting. Among these are tours of the Acme Steel Company, Ridgeland Station of Commonwealth Edison Company, Zenith Radio Company plant, Swift and Company, WNBQ color tele-

Courtesy Toivo Kaitila

THOSE JOINING the inspection trip held Thursday noon, October 4, will see how a modern color television studio and station operate at NBC's WNBQ atop the Merchandise Mart. An actual broadcast will be made during the trip.

Acme Steel Photographic Department

AERIAL VIEW of the Acme Steel plant in Riverdale shows the largeness of its operation. Those who attend the field trip to this plant, Tuesday morning, October 2, will inspect the mill-type electrical equipment and be able to see how hot mills, cold strip mills, and galvanizers operate.

A BUS TRIP to the Ridgeland Station of the Commonwealth Edison Company will take place Wednesday morning, October 3. Shown are control panels for the four units of this 600,000-kw base load station which should interest the lighting engineer as well as the power generation man.

vision studio, Prudential Building, Kellogg Switchboard Company, and International Business Machines (IBM) office.

Members are urged to register in advance for all trips as the number that can be accommodated on the various trips is limited. In making trip reservations, members should include names, citizenship, business connections, and checks for bus fees. Aliens should give advance notice of plans to make inspection trips.

Transportation will be by chartered bus in each case, except for the Prudential Building, WNBQ-TV studios, and IBM, which are within easy walking distance of the Morrison Hotel. Bus fare will be $2 for each trip.

Send trip registrations and fees to: H. E. Nason, Westinghouse Electric Corporation, Room 262 Merchandise Mart Plaza, Chicago 54, Ill. Tickets will be held in members' names at the Trips Registration Desk for pick-up during the convention.

Acme Steel Company and *International Business Machines Office* (Tuesday all day, October 2). A trip by special bus in the morning to the Acme Steel Company located in Riverdale will provide an opportunity to see mill-type electrical equipment, and to witness the operation of hot mills, cold strip mills, and galvanizers.

After lunch, available at nominal cost in the Acme cafeteria, there will be a walking trip to the IBM office in the Loop where a demonstration of rotating machine calculations will be made on a digital computer, IBM *650*.

Ridgeland Station (Wednesday morning, October 3). A bus trip will take visitors to the Ridgeland Station of the Commonwealth Edison Company located in nearby Stickney. This is a very modern 600,000 kw station with four generators, located on the Illinois Waterway which supplies condensing water and provides for delivery of coal by barge to a unique gantry crane. Of particular interest, are the cyclone furnaces in the boilers and the modern coal-handling equipment.

Zenith Radio Company (Wednesday afternoon, October 3). A trip by bus is planned to the plant of the Zenith Radio Company, one of the largest in the industry, where there will be an opportunity to see modern methods of production of both radio and television receivers and, it is hoped, hearing aids.

Swift and Company (Thursday morning, October 4). There will be a bus trip to the famous Chicago Stockyards and a tour through the facilities of Swift and Company, where each may see the processing of "Premium" products.

WNBQ-TV (Thursday noon, October 4). A short walking trip will take place to the color studios of WNBQ-TV, located atop the Merchandise Mart, where it will be possible to see studios, equipment, and also an actual program as it is being broadcast during the noon hour.

Prudential Building (Thursday afternoon, October 4). A short walk will take visitors to the Prudential Building, the newest of Chicago's skyscrapers, which has the fastest automatic elevators; the highest lighting intensity; an observation platform at the 600-foot level, available for a nominal fee of 50¢; and a popular cocktail lounge.

Kellogg Switchboard Company (Friday morning, October 5). There will be a trip by bus to the Kellogg Switchboard Company, one of the oldest independent manufacturers of telephone, central-office-to-subscriber equipment. Kellogg recently became a division of the International Telephone and Telegraph Company.

Registration

Members can simplify registration procedure by returning advance registration cards promptly. This will save time in completing details upon arrival at the hotel. The registration desk at the hotel will be open during the get-acquainted Tea on Sunday afternoon, and from 8 a.m. to 4 p.m. daily, thereafter, during the convention. The registration fee will be $5 for members and $8 for nonmembers. No fee will be required for immediate families of members or for student members.

Committee

Desiring to make the Fall General Meeting a memorable one are the following Committee members: General Chairman W. M. Ballenger; Vice-Chairman G. L. Welch; Secretary E. F. Koncel, Jr.; Treasurer F. M. Scott; M. J. Adams, special activities; D. H. Beal, Fall Frolics; J. F. Bracken, hospitality; B. T. Carmody, hotel arrangements; E. H. Finch, finance and budget; D. F. Hayworth, sale of papers; C. F. Hill, technical program and monitors; Mrs. F. A. Larson, ladies; F. A. Larson, entertainment; D. L. Levine, registration; H. E. Nason, trips and transportation; J. A. Romano, general session; and J. T. Tyner, publicity.

First Recipient of New AIEE Medal Announced

The AIEE Members-for-Life Fund Medal in Electrical Engineering Education will be awarded for the first time to Dr. F. E. Terman, provost of the University and dean of the School of Engineering, Stanford University, during the Fall General Meeting in Chicago, Ill.

The newly established Medal, to be awarded to a teacher of electrical engineering, is based on ". . . excellence in teaching, ability to inspire students to higher achievements, contributions to the teaching of electrical engineering in textbooks and in writings on engineering education, active participation in the work of the professional and educational societies, and contributions to teaching and the profession through research, engineering achievements, and technical papers."

The presentation will take place at a special session to be held at 1:45 p.m., Tuesday, October 2, 1956, during the General Meeting.

A biographical sketch of Dr. Terman appears on page 864 of this issue of *Electrical Engineering*.

AIEE Fall General Meeting, Chicago, Ill., October 1–5, 1956

Tentative Technical Program

Monday, October 1

9:00 a.m. Rotating Machinery

56-935. A New Method for Determining Sequence Impedances of Small Synchronous Machines. *W. K. Gardner*, Naval Research Laboratory

56-936. Capacitive Loading of Saturated Synchronous Machines—Part 1. *S. L. Mikhail, C. A. Keener*, University of Illinois

56-925. In-Service Temperature Measurement of the Amortisseur Winding of Large Frequency Changers. *P. K. Pavlides*, Philadelphia Electric Company

CP56-1013 Synchronizing Out of Phase. *A. J. Wood*, General Electric Company

CP56-937. The Synchronous Double Fed Induction Machine. *R. E. Bedford*, Indian Institute of Technology

9:00 a.m. Protective Devices

CP56-939. Application of Expulsion Arresters on Cable-Connected Equipment. *C. J. Baldwin, Jr., J. M. Clayton*, Westinghouse Electric Corporation

CP56-973. Lightning Protection of Unit-Connected Turbine Generators—Field and Laboratory Studies. *A. P. Hayward*, Duquesne Light Company; *J. K. Dillard, A. R. Hileman*, Westinghouse Electric Corporation

56-974. Design and Operating Features of an Expulsion Arrester Without Follow Current. *C. L. Stroup, Alex Vitkus, A. C. Westrom*, Hubbard and Company

9:00 a.m. Metallic Rectifiers

56-975. The Fused Silicon Rectifier. *H. W. Henkels*, Westinghouse Electric Corporation

56-934. Rating and Application of Germanium and Silicon Rectifiers. *F. W. Gutzwiller*, General Electric Company

CP56-976. Direct Water-Cooled Germanium Power Rectifiers. *R. E. Wahl*, General Electric Company

CP.* A Comparison of Tests for Selenium Rectifiers. *D. A. Klopfer*, Westinghouse Electric Corporation

CP.* Selenium Rectifiers and Their Aging Characteristics. *C. E. Brigham*, Richardson-Allen Company

9:00 a.m. Land Transportation

56-977. Power Supply for Commercial Frequency Railroad Electrification. *J. C. Price*, General Electric Company

CP.* Design Fundamentals of Diesel-Electric Locomotive Control Systems. *A. V. Johansson*, General Electric Company

CP.* Development of Wiring Diagram Standards for Land Transportation Vehicles. *C. W. Martin, H. S. Ogden*, General Electric Company

CP56-978. Mobile Axle Flaw Detector Unit Carrier and Method Used to Ferret Out Defective Car Journals on the Chesapeake and Ohio. *E. R. Hauer, C. M. Angel*, Chesapeake and Ohio Railway Company

56-979. Modernization of the Long Island Rail Road Passenger Car Fleet. *P. H. Hatch*, The Long Island Rail Road Company. Re-presented for discussion

2:00 p.m. General Session

Tuesday, October 2

9:00 a.m. Rotating Machinery

56-938. Induction Machinery Design Being Revolutionized by the Digital Computer. *C. G. Veinott*, Reliance Electric and Engineering Company

CP56-956. Polyphase Induction Motor Design by Digital Computer. *A. E. Hartman*, Robbins and Myers, Inc.

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33 West 39th Street,
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56-922. The Application of Computers to the Solution of Induction Motor Thermal Circuits. *A. E. Johnson*, General Electric Company

CP56-940. Application of High Speed Electronic Computer to Generator Design Problems. *W. C. Brenner, R. Schinzinger, R. M. Suarez*, Westinghouse Electric Corporation

9:00 a.m. Safety

CP56-947. The Use of Nickel Cadmium Batteries in Emergency Lighting Applications. *Theodore Ulrich*, Nickel Cadmium Battery Corporation

CP.* Dry Batteries in Emergency Equipment. *R. C. Clock*, Burgess Battery Company

CP56-948. Electric Shock Hazard Analysis. *K. S. Geiges*, Underwriters' Laboratories, Inc.

9:00 a.m. Transformers

56-949. The Rigorous Solution of an Electrostatic Field by Means of the Card Programmed Calculator. *J. R. Failloes, L. Rabins*, General Electric Company

56-916. A Zero-Sequence Equivalent Circuit of Autotransformer Connections Which Yields Neutral Shift. *B. A. Cogbill*, General Electric Company

56-950. Bushing-Type Current Transformers for High-Accuracy Revenue-Metering Equipment. *J. M. Vanderleck*, The Hydro-Electric Power Commission of Ontario

56-926. Correlation Between the Breakdown Strength of Large Oil Gaps and Oil Quality Gauges. *A. F. Rohlfs, F. J. Turner*, General Electric Company

56-918. Effects on Transformer Insulation Structures of Long Duration Waves Representative of Switching Surges. *H. E. Fiegel, J. S. Kresge*, General Electric Company

9:00 a.m. Television and Aural Broadcasting

CP.* Closed Circuit Color TV at Walter Reed Hospital. *L. E. Anderson*, Radio Corporation of America

56-972. Field Experience With the A2A Video System. *R. W. Gast*, New York Telephone Company

CP.* R-F Diplexing in Color TV and Aural Relaying. *T. G. Custin*, General Electric Company

9:00 a.m. Experiences with Conductor for Industrial Systems

CP56-1002. Mineral Insulated Cable in Heavy Industry. *F. E. Maurer*, Olin Mathieson Chemical Corporation

CP56-1003. Bus Duct—An Experience Report *J. B. Cataldo*, BullDog Electric Products Company; *H. A. Geisendorfer*, Chrysler Corporation; *Nelson Kein*, Albert Kahn Associates

CP.* Experiences in the Termination of Aluminum Wire and Cable in Industrial and Commercial Applications. *Henry Esch*, Kaiser Aluminum and Chemical Corporation

1:45 p.m. Presentation of the Members-for-Life Fund Medal in Electrical Engineering Education to Dr. F. E. Terman

2:30 p.m. Television and Aural Broadcasting

CP.* Television Allocation Trends. *O. W. B. Reed, Jr.*, Jansky and Bailey Consulting Engineers

CP.* System Aspects of Trospheric Scatter. *William Collins*, Page Communication Engineers

CP.* Maintenance of TV Antennas and Transmission Lines. *L. O. Krause*, General Electric Company

CP.* The Zenith Royal 500 All Transistor Radio. *George Moore*, Zenith Radio Corporation

2:30 p.m. Insulated Conductors

56-951. Aluminum Sheathed Cable—A Utilisation Wiring System for Industrial and Domestic Distribution. *P. J. Croft*, Canada Wire and Cable Company, Ltd.

56-952. The Heating and Mechanical Effects of Installing Insulated Conductors in Steel Raceways. *M. M. Brandon, K. S. Geiges, L. M. Kline, F. V. Paradiso*, Underwriters' Laboratories, Inc

56-953. The Properties of Tellurium Alloy Lead Sheath for Power Cable. *H. A. Hoover*, John A. Roebling's Sons Corporation

CP56-964. A Further Examination of Protective Coverings for Metallic Sheathed Cables and for Pipes. *D. M. Farnham*, Quebec Hydro-Electric Commission

CP56-988. Corrosion Control on the Underground System of the Philadelphia Electric Company. *R. C. DeMarco, J. E. Johnson*, Philadelphia Electric Company

2:30 p.m. Chemical Industry

2:30 p.m. Basic Sciences

56-980. Accurate Determination of the Capacitance of a Thin Rectangular Plate. *D. K. Reitan, T. J. Higgins*, University of Wisconsin

56-981. Integrated *S*-Plane Synthesis Using Two Way Root Locus. *John Zaborszky*, Washington University

56-982. Analysis of Linear Sampled-Data Systems With Finite Pulse Width (Open Loop). *G. Farmanfarma*, University of California

56-983. A New Method for Treating Nonlinear Problems with Applications to Iron-Cored Oscillatory Circuits: I—Sub-Harmonics Do Not Exist. *M. Kamal Gohar*, Cairo University. For Discussion Only

56-984. Electrical Units and Dimensions. *Leo Young*, Westinghouse Electric Corporation

2:30 p.m. Management

Wednesday, October 3

9:00 a.m.

Panel Discussion of the Use of Digital Computers in the Design of Rotating Machines

Moderator: E. C. Barnes, Reliance Electric and Engineering Company

Panel Members: Abraham Covo, Westinghouse Electric Corporation; E. L. Harder, Westinghouse Electric Corporation; A. E. Hartman, Robbins and Meyers, Inc.; Verner Kempinen, General Electric Company; R. M. Saunders, University of California; C. G. Veinott, Reliance Electric and Engineering Company; J. C. White, General Electric Company

9:00 a.m. Telegraph Systems

56-985. A Data Transmission Machine. *C. R. Doty, L. A. Tate*, International Business Machines Corporation

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* Conference papers will not be printed by the Institute; they may be available, however, at the meeting at the discretion of the author.

CP56-936. A High Speed Fully Automatic Teleprinter Switching System for Brokerage Firms. *C. J. Holleman,* Western Union Telegraph Company

56-987. A Transistorized Time Division Multiplex Telegraph Set. *F. D. Biggam,* Teletype Corporation

CP.* Transmission of Newspapers by Facsimile Over a Wide Band Channel. *A. G. Cooley, J. R. Shonnard,* Times Facsimile Corporation

9:00 a.m. Communication Theory

56-928. The Technical Feasibility of Translating Languages by Machine. *V. H. Yngve,* Massachusetts Institute of Technology

CP.* Some Studies of Visual Perception Speed. *G. C. Sziklai,* Radio Corporation of America

CP56-963. Moment Detection and Coding. *J. J. Slade, Jr., S. Fich, L. F. Nanni, D. A. Molony,* Rutgers University

56-653. The Communication Engineer's Needs in Information Theory. *W. T. Rea,* Bell Telephone Laboratories, Inc. Re-presented for discussion.

9:00 a.m. Mining and Metal Industry

CP.* Predicting Performance of Large Power Shovels. *L. A. Moucha, M. A. Neslin,* General Electric Company

CP.* Lower Operating Costs Thru Statistical Analysis of Motor Failures. *J. M. Jenkins,* Reliance Electric and Engineering Company

CP.* Automatic A-C Mine Hoist at Trotter Coal Company. *W. [illegible] Thomas,* Westinghouse Electric Corporation

CP.* Report of AIEE Conversion Substation Committee on D-C Grounding Practices. *R. R. Godard,* U. S. Steel Corporation

9:00 a.m. Feedback Control Systems

56-954. Analysis of Servomechanisms with Nonlinear Feedback Control. *Y. H. Ku,* University of Pennsylvania

56-958. Variably Damped Servomechanisms. *L. Schieber,* International Business Machines Corporation

CP56-959. The Design of a Completely Static Accurately Regulated Power Supply. *R. G. Hoft, M. A. Head,* General Electric Company

CP.* Transient Signal Analyzer. *J. B. Reynolds, Jr.*

1:45 p.m. Automation

2:30 p.m. Rotating Machinery

CP.* Calculation of Windage Noise Power Level in Large Induction Motors. *M. E. Talaat,* The Elliott Company

CP.* Sound Power Measurements on AIEE Noise-Test Motor by Different Laboratories. *A. F. Lukens,* General Electric Company

CP.* Noise Reduction in Electrical Machinery for Shipboard Installation. *Samuel Feldman,* Bendix Aviation

CP.* Reduction of Motor Noise in the Field. *R. H. Lee, Vaughn Hill*

2:30 p.m. Switchgear

56-989. Isolated Phase Telescoping Bus Duct. *S. C. Killian, K. Boyajian,* H. K. Porter Company, Inc.

CP56-990. Switching Properties of Vacuum. *Mohamed Khalifa,* University of Cairo

CP56-991. A New 115 KV, 1000 MVA Gas Filled Circuit Breaker. *C. F. Cromer, R. E. Friedrich,* Westinghouse Electric Corporation

CP56-992. Interruption of Capacitance Charging Currents in Sulfur Hexafluoride. *T. E. Browne, Jr., A. P. Strom,* Westinghouse Electric Corporation

2:30 p.m. System Engineering

56-921. The Depreciation Annuity. *P. H. Jeynes,* Public Service Electric and Gas Company

56-923. The Solution of Power System Stability Problems by Means of Digital Computers. *D. L. Johnson,* University of Washington; *J. B. Ward,* Purdue University

CP.* Committee Report on Current Status of Load-Frequency Control Methods and Equipment by the System Controls Subcommittee of the Committee on System Engineering. Presented by C. N. Metcalf.

2:30 p.m. Mining and Metal Industry

CP.* Class H Insulation for Heavy Duty D-C Motors. *F. C. Kreitler,* General Electric Company

CP.* Silicone Insulation in Mining Machine Motors. *J. A. Buss,* Reliance Electric and Engineering Company; *F. R. Hugus,* Joy Manufacturing Company

CP.* Rewinding Electrical Equipment With Silicone Class H Insulation. *R. L. Bogardus,* Westinghouse Electric Corporation

2:30 p.m. Feedback Control Systems

56-924. Nonlinear Control System Response to Random Signals. *P. N. Nikiforuk,* Canadian Armament Research and Development Establishment

56-960. A Note on the Describing Function of an Element with Coulomb, Static, and Viscous Friction. *M. Y. Silberberg,* Yale University

CP56-961. Sampled-Data Analysis of a Drift-Stabilization System. *P. G. Pantazelos,* Massachusetts Institute of Technology

56-962. A Technique for the Analysis of Time-Varying Sampled Data System. *Bernard Friedland,* Columbia University

Thursday, October 4

9:00 a.m. Rotating Machinery

56-941. Thermal Analysis of a Small D-C Motor—Part 1, Dimensional Analysis of Combined Thermal and Electrical Processes. *J. Kaye, S. W. Gouse, Jr.,* Massachusetts Institute of Technology

56-942. Thermal Analysis of a Small D-C Motor—Part II, Experimental Study of Steady-State Temperature Distribution in a D-C Motor With Correlations Based on Dimensional Analysis. *J. Kaye, S. W. Gouse, Jr., E. C. Elgar,* Massachusetts Institute of Technology

56-930. Losses in Idle Conductors in D-C Machine Armature Slots. *Edward Erdelyi, F. T. DeWolf,* General Electric Company

CP56-943. Carbon Brush Capacity Calculations. *J. G. Wilhite,* Westinghouse Electric Corporation

CP.* Problems in Standardizing Per Unit Quantities. *R. M. Fisher, Jr.,* General Electric Company

9:00 a.m. System Engineering

CP56-1008. Digital Computers Can Aid Utilities. *F. J. Maginniss,* General Electric Company

CP56-1006. What Is a Digital Computer? *H. A. Peterson,* University of Wisconsin

CP56-965. Elementary Problem and Preparation—Flow Diagrams. *E. L. Harder,* Westinghouse Electric Company

CP56-966. Organization and Personnel. *E. R. Moore,* The Detroit Edison Company

9:00 a.m. Ethics

CP.* A Proposed NSPE Brochure on Rules of Professional Conduct for Engineers. *O. H. Hall,* chairman, National Committee on Ethical Practices of the National Society of Professional Engineers (NSPE)

CP56-1012. The ECPD Program in the Field of Engineering Ethics. *Dean C. J. Freund,* University of Detroit, chairman, Engineers Council for Professional Development (ECPD) Committee on Ethics

9:00 a.m. Radio Communications

56-968. Propagation Test on 955.5 MC, 1,965 MC, and 6,700 MC. *H. R. Mathwich,* Radio Corporation of America; *A. M. Randolph, E. D. Nuttall,* United Gas Corporation; *J. E. Pitman,* Philco Corporation

CP56-969. A Simple Method of Power Transformer Design. *H. S. Sear,* Sanborn Company

CP56-970. Design of Wide-Band RF Transformers Utilizing A Synthesized Equivalent Network. *H. H. Kajihara,* Headquarters, Signal Corps Engineering Laboratories

CP56-1001. Some Results with Frequency Diversity in a Microwave Radio System. *F. H. Willis,* Bell Telephone Laboratories, Inc.

2:00 p.m. Rotating Machinery

56-944. An Electric Speed-Torque Device Based on Magnetic Principles. *W. L. Probert,* A. O. Smith Corporation

56-945. Performance Calculations on Capacitor Motors by the Cross-Field Theory. *P. H. Trickey,* Wright Machinery Company

56-917. Graphical Determination of Starting Performance of Capacitor Motors. *A. Covo,* Westinghouse Electric Corporation; *L. E. Lingo,* Syracuse University

56-915. Performance Calculations for Part-Winding Starting of Three-Phase Motors. *P. L. Alger,* General Electric Company

56-946. Speed Control of Induction Motors Using Saturable Reactors. *P. L. Alger,* General Electric Company; *Y. H. Ku,* University of Pennsylvania

2:00 p.m. System Engineering

CP56-967. Principles of Programming. *J. B. Ward,* Purdue University

CP.* Electro Mechanical Accounting Machines for Power Engineering. *L. A. Dunstan,* Diginetics, Inc.

CP56-1000. Use of Digital Computers in Co-ordination of System Generation. *P. L. Dandeno,* Hydro-Electric Power Commission of Ontario.

56-920. Digital Calculation of Short-Circuit Currents in Large Complex-Impedance Networks. *L. W.*

NIGHT VIEW of Chicago, Ill., looking north on Michigan Ave. This city will be host to the AIEE Fall General Meeting, October 1–5, 1956.

Coombe, Detroit Edison Company; *D. G. Lewis*, General Electric Company

2:00 p.m. Wire Communications Systems

CP.* Treatment of Wire Lines for Radio and Multiplex Application. *E. E. Combs*, Lynch Electric Company

CP.* A Frequency Converting Telephone Carrier Repeater for Military Use. *G. Goltzes, J. H. Johnston*, Signal Corps Engineering Laboratory; *R. B. Anderson*, Lenkurt Electric Company

CP.* Automatic Telephone Answering Service. *J. M. Standring, Jr.*, American Telephone and Telegraph Company

56-929. Multi-Unit Neutralizing Transformers. *T. F. Palmquist*, Bell Telephone Company of Canada

56-971. Lightning Protection on the Stevens Point-Wisconsin Rapid Inter-City. *R. C. Dowling*, Wisconsin Telephone Company

2:00 p.m. Education—The Science of Materials in Electrical Engineering Practice

CP.* A Material Producers' View of the Electrical Equipment Manufacturing Industry. *A. Pechukas*, General Electric Company

CP56-1009. Influence of Materials on the Electrical Product. *P. S. Potts*, General Electric Company

CP56-1007. Semiconductor Materials and Electrical Engineer. *Gene Strull*, Westinghouse Electric Corporation

CP56-1014. The Modern Science of Materials for Electrical Engineers. *W. W. Mullins*, Westinghouse Electric Corporation

Friday, October 5

9:00 a.m. Transmission and Distribution

56-993. A New Approach to the Study of Simultaneous Unbalances. *H. A. Peterson, J. J. Skiles, I. J. Nagrath*, The University of Wisconsin

56-994. An Analysis of the Radio Interference Characteristics of Bundled Conductors. *G. E. Adams*, General Electric Company

CP56-999. Switching Surges Due to De-energization of Capacitive Circuits. Working Group on Switching Surges

9:00 a.m. Communication Maintenance

CP56-1005. The New Emphasis in Maintenance for Communications Systems. *W. K. MacAdam*, American Telephone and Telegraph Company

CP.* Maintenance Problems and Considerations in the Independent Telephone Industry. *B. L. Arnold*, Automatic Electric Sales Corporation

CP.* Manufacturer's Program for Equipment Maintenance. *G. D. Wallenstein*

9:00 a.m. Power Generation

CP56-995. Excitation Voltage Response Definitions and Significance in Power Systems. *M. Temoshok, F. S. Rothe*, General Electric Company

56-996. Excitation System Response—A Utility Viewpoint. *P. L. Dandeno, K. R. McClymont*, The Hydro-Electric Power Commission of Ontario

CP.* Tests of Excitation System Transient Performance. *R. W. Ferguson, T. J. Bliss*, Westinghouse Electric Company

CP.* Defining Excitation System Response. *H. W. Cory, W. F. Eagan*, Allis-Chalmers Manufacturing Company

9:00 a.m. Industrial Control

56-652. Protecting A-C Motors with Low-Voltage Air Circuit Breaker Series Trips. *F. P. Brightman, P. J. Reifschneider, R. R. McGee*, General Electric Company

CP56-955. Application of Magnetic Logic Elements to the Control of an Automatic Bus Duct Welder. *J. P. Corner*, Westinghouse Electric Corporation

56-932. A Pressure Control Switch with a Pulsation Filter. *L. P. Schaefer*, The Hinchman Corporation

CP.* An Improved Method of Phase Failure Protection. *W. Kniel*

2:00 p.m. Transmission and Distribution

56-933. Report of a Survey on Controls for Automatically Switched Capacitors. Working Group of the AIEE Subcommittee on Capacitors

CP56-1004. Computer Simulates Water Heater Operation for Demand Analysis. *H. E. Campbell, R. Habermann, Jr.*, General Electric Company

CP.* Effect of Atmospheric Contamination on Generated Radio Influence Voltage. *C. J. Miller*

2:00 p.m. Power Generation

CP56-997. Steam Station Auxiliary Systems for Large High Pressure Turbine-Generator Units. *A. C. Dolbec, J. J. Heagerty, A. G. Mellor*, General Electric Company

CP56-998. Simplicity of Station Design and Operation With Cross-Compound Turbine Generator Sets. *P. E. Benner, P. G. Brown, R. C. Buell, A. G. Mellor*, General Electric Company

2:00 p.m. Seminar on Educational Electronics

2:00 p.m. Communication Maintenance

CP*. Over-all Aspects of Telegraph Maintenance. *R. Hoover*, Western Union Telegraph Company

CP.* Transmission and Reliability Maintenance of Type TD2 Radio Relay Systems. *E. T. Fruhner, R. D. Service*

CP.* Importance of Fringe Tests in Vacuum Tube Maintenance. *D. S. Wise*, Hickock Electrical Instrument Company

Over 2,000 Members and Guests Enjoyed Summer and Pacific Meeting

MEMBERS WHO ATTENDED the 1956 AIEE Summer and Pacific General Meeting in San Francisco, Calif., will have pleasant memories of a warm welcome and warm hospitality—in fact, everything was warm except the weather, and that was delightfully cool.

The full week, June 25–29, of social and technical activities at the Fairmont Hotel was enjoyed by more than 2,000 members and guests. The inspection trips and sports—chiefly for the men—and the ladies' varied program, kept everyone fully occupied who felt the need of relaxation after attending the 65 technical sessions in the comfortable and beautifully appointed rooms of the Fairmont and Mark Hopkins Hotels.

RELAXING between sessions during the Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, were (*left to right*) Dr. A. B. Du Mont, president, Allen B. Du Mont Laboratories, Inc.; AIEE President M. D. Hooven; and Dr. C. R. Hanna, winner of the Lamme Medal.

The social activities began on Sunday afternoon, with a welcoming tea for the early arrivals. Each day, Monday through Thursday, there was a formal luncheon. On Monday, George Christopher, San Francisco's mayor, was honored; on Tuesday, Dr. F. E. Terman, Stanford University's dean of engineering and provost, addressed the luncheon guests; George White, general manager of General Electric Company's atomic power equipment department, addressed Wednesday's luncheon; and, on Thursday, the luncheon address was made by J. R. Kiely, vice-president, Bechtel Corporation.

On Thursday evening, the President's Reception and banquet was held, followed by dancing. Each day of the meeting, one or more inspection trips were scheduled and these were well attended and enjoyed.

For those who were inclined more to sports than technical matters, there was golf at the Lake Merced Golf and Country Club, with a tournament on Tuesday. On Thursday, some of the more hardy early risers left their hotels about 5:30 a.m., and embarked on the "AIEE Fishing Fleet" for the Salmon Derby. Winners of these events are listed further along in this article.

Luncheons

Dr. Terman in his address at the Tuesday

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MEETING HIGHLIGHTS

Summer and Pacific General Meeting

AIEE PRESIDENT M. D. HOOVEN (*top picture*) pins his president's badge on President-elect M. S. Coover who will head the Institute for the coming year. *Below, left:* Principal speakers at the General Session, including N. S. Hibschman, AIEE secretary; Dr. C. R. Hanna, Lamme medalist; Dr. J. A. Hutcheson, vice-president, Westinghouse Electric Corporation; W. G. Collins, Section chairman, San Francisco, Calif; Bradley Cozzens, District 8 vice-president; George Christopher, mayor, San Francisco, Calif.; J. S. Moulton, general meeting chairman; Dr. A. B Du Mont, president, Allen B. Du Mont Laboratories, Inc.; and D. I. Cone, AIEE director. *Below, right:* A general view of the audience during the General Session.

luncheon, said that Russia is alleviating its shortage of trained engineers by using the good old capitalistic free enterprise technique of making the carrot for engineers larger and juicier. To increase the supply, they have raised the price of engineers.

He cited comparative monthly pay scales of USSR workers: unskilled, 600 rubles; skilled, 1,000 rubles; beginning graduate engineers, 2,000 rubles; department store manager, 3,000 rubles; senior research engineer, 10,000–30,000 rubles. Although wage rates for young United States engineers have improved greatly since the 30's and 40's, if their wages are compared with the hourly rates of coal miners, automobile workers, or longshoremen, engineers are just about holding their own.

Russia is producing about 50,000 engineers annually, plus correspondingly large numbers of physicists and other scientists. In 1955, we produced 22,000 bachelors of science, which is far short of our requirements. Quoting from the U.S. Office of Education statistics, Dr. Terman stated that the proportion of entering college freshmen who chose engineering increased from 16 per cent in 1952 to only 16.9 per cent in 1955.

At the Wednesday luncheon, Mr. White said the rapid development of atomic power into a healthy, peacetime industry depends on integration into our free enterprise system. We are not investing millions of dollars in this development just because it is a unique way of producing electricity. Atomic power is important only because all energy is important. The foundation of our whole standard of living rests on abundant energy.

The big problem is to make atomic power plants economically feasible. Today, and for several years to come, they can be expected to cost 50 to 80 per cent more than conventional plants because of the high cost of the components. When engineers and physicists have found how metals and other materials behave under radiation, they must combine them to find the economical design.

"Engineering Aspects of Western Industrial Growth" was the subject of Mr. Kiely's talk at the luncheon on Thursday. In tracing the population growth in 11 western states, he predicted that by 1975, 40 million people will be living in these states.

In 1900, there were 250 workers in our economy to one engineer; in 1925, the ratio was 100 to 1; in 1950, 50 to 1 engineer; and in 1975, he estimated that for every 20 workers, there will be 1 engineer. Plant and equipment expenditures in 1950, were $2.5 billion; 1960, the annual rate will exceed $5 billion; and by 1975, it will be $7.5 billion.

Of unusual significance, are the three fundamental problems in the West: power, fuel, and water. At the end of 1955, the West had 20 million kw of capacity. At the end of 1965, it will need double this amount; if predictions are accurate, and if the need continues to increase, by 1975, a vast program of both hydro and steam construction will be necessary.

In regard to fuel, California's requirements now are about 4 trillion thermal units daily. One quarter is supplied by its own natural gas of about one billion cubic feet per day. Three eighths comes from fuel oil, and the rest from imported gas. If these requirements increase by a conservative 4 or 5 per cent per year, it is necessary to think in terms of 150–200 million cubic feet per day, year after year.

The third problem—water—is caused by California's peculiar situation, where about 75 per cent of the water falls north of the San Francisco-Sacramento line and about 75 per cent of the demand for such water exists south of the line. A master plan has been made to co-ordinate the water needs of all areas in the state and reviews possible effects of nuclear energy, sewage reclamation, and salt-water conversion. The cost of this plan is of the order of $11.5 billion.

The Annual Meeting

The meeting was opened by J. S. Moulton, the chairman of the general meeting committee. He introduced George Christopher, the mayor of San Francisco, who welcomed the members to the city. He spoke about the engineering investments in San Francisco and stated that the population of the state was increasing by about 30,000 people monthly. He urged businessmen to look toward California as a future place for industry.

Mr. Moulton next introduced Bradley Cozzens, vice-president of District 8, and W. G. Collins, chairman of the San Francisco Section. After brief talks from each of these members, AIEE President Hooven was introduced, and presented "Where We Stand," *Electrical Engineering*, August 1956, page 679.

IN CONVERSATION during the Summer and Pacific General Meeting, San Francisco, Calif., were (left to right) J. S. Moulton, chairman, General Committee; George Christopher, mayor of San Francisco, who welcomed guests and members; Bradley Cozzens, District 8 vice-president; and D. A. Anzini, vice-chairman, General Committee.

AIEE Treasurer W. J. Barrett presented a summary of the Institute's financial condition, *Electrical Engineering*, August 1956, page 758. He stated that the finances of the Institute were in a healthy condition, and that the net cost of publications has been reduced from a high of $171,000 in 1955 to $97,000 in the year ending April 30, 1956. In the coming year, the estimated net cost will be $87,500. These gains are attributed to increased income from advertising, the use of a less expensive paper, and a slight decrease in number of pages in *Transactions*.

AIEE Secretary N. S. Hibshman then read the Committee of Tellers' report, stating that the AIEE constitutional amendments had been accepted by about 17,000 favorable votes and that the slate of officers for the coming year had been elected.

AIEE President Hooven then presented the President's badge to President-elect M. S. Coover, who expressed his gratitude to the members for his election and asked the co-operation of everyone during his term of office.

Following this, Mr. Hooven introduced the new vice-presidents and the new members of the Board of Directors.

H. H. Shephard recalled that in 1953, the Board of Directors had voted to commemorate the birthday of Benjamin Franklin. In recognition of the part the Institute played in this celebration, the Poor Richard Club of Philadelphia, Pa., presented to the Institute, through Mr. Shephard, its Almanac Award and Medal. These were accepted for the AIEE by Mr. Hooven.

Membership in the American Institute of Electrical Engineers, including a subscription to this publication, is open to most electrical engineers. Complete information as to the membership grades, qualifications, and fees may be obtained from Mr. N. S. Hibshman, Secretary, 33 West 39th Street, New York 18, N. Y.

The 28th annual award of the Lamme Medal was made to C. R. Hanna, Westinghouse Electric Corporation. In the absence of J. J. Pilliod, D. I. Cone read the history of the Medal, Dr. J. A. Hutcheson detailed the career of the medalist, and Mr. Hooven presented the metal to Dr. Hanna. The complete text appears in the August 1956 issue of *Electrical Engineering* on pages 706–9.

Mr. Cone then presented Dr. A. B. Du Mont who presented the main address, "Vision in Electronics." The complete text appears in this issue of *Electrical Engineering*, pages 773–5.

Competition Winners

The winners of the salmon derby and the golf prizes were announced by O. A. Gustafson, chairman of the Sports Committee, at the Thursday luncheon. The catch for eight boats with 70 fishermen, was 166 salmon, weighing approximately 2,000 pounds. First prize went to Mrs. J. C. Strasbourger of Cleveland, Ohio, for a 25-pound, 8-ounce salmon. Second prize was won by Ray Waggoner, Jr., of Piedmont, Calif., with a 24-pound catch, and third prize was won by C. G. Krause of San Antonio, Tex., for a 23-pound, 8-ounce salmon.

The winner of the John B. Fisken cup was W. H. Peterson of Oakland, Calif., with an 82 gross–67 net. The competition took place at the Lake Merced Golf and Country Club course. Second prize was won by E. G. Norell of Chicago, Ill., with a 74 net, third prize went to Dale Evans of Palo Alto, Calif., with a 76 net, and fourth prize was taken by G. M. Farly of Berkeley, Calif., with a 76 net as he lost on the draw.

Also at this time, Prof. C. F. Dalziel, chairman of the Student Activities at this meeting, introduced the first-prize winners from the various Districts' student paper competitions. The complete details appear in "In Educational Circles," page 867.

Section Delegates Conference Considers Many Important Problems

THE CONFERENCE of the Section Delegates which was held on Tuesday, June 26, during the Summer and Pacific General Meeting, discussed a wide variety of important problems such as student activities, membership, transfers, unity of the profession, finances, education, and vocational guidance. The conference was called to order by Dixon Lewis, chairman of the Sections Committee. Much of the meeting, including an evening session devoted to the organization of technical groups in the sections, was conducted by employing the principles of "group dynamics." The actions of the Sections Committee were briefly reported, including recommended revision to simplify the bylaw in regard to Section territory.

Welcome by President Hooven

In a cordial welcome, President Hooven said that to welcome the Section Delegates was one of the pleasant duties of the office. The Section chairmen are the leaders who take their legions forward on many Institute fronts. He said it was a privilege for them to go home and plan an active, successful year ahead which would be one of the most interesting, active years of their lives.

Section Growth Awards

The Section growth awards based on increases in membership and attendance at meetings in two classes, larger than average Sections and smaller than average Sections, as announced in *Electrical Engineering*, September 1955, page 825, were as follows: In the larger than average class, first place went to the Toronto Section, second to Los Angeles Section. In the smaller than average class, the San Diego Section won first place and the Jacksonville Section second.

Section Operations Manual

A 28-page manual developed by a Subcommittee on Operations Manual (Director R. E. Kistler, chairman) was brought to the attention of the delegates. The manual contains basic information on the organization and operation of a section which used to be contained in the Secretary's letter, and which now has been consolidated in standard size and arrangement. The manual will be kept up to date and revised every two years.

Student Activities

Referring to student enrollment, Lee Nonemaker explained that the Institute had done better recruiting than during 1955–56. Student enrollement as of May 1, 1956, was 9,458, representing a 26 per cent increase over the previous year. The Sections have aided the Student Branches in the following ways: by providing extra money for prizes, special students nights, speakers, and $100 scholarships to winning seniors.

Membership Activities

Memberships have reached a high level as reported by W. E. Scholz, chairman of the Membership Committee. The total number of members reached 49,949 with 300 more applications received during the year as compared with the previous year. Resignations were 1,014 compared with 414 for the previous year, and 3,000 were in arrears as against 1,961 last year. There may possibly be a higher number of reinstatements. The national committee has more or less decentralized and Mr. Scholz explained that campaigns or contests differed in the various territories.

Unity of the Profession

The views of the Pittsfield Section in regard to unity of the engineering profession were presented by W. E. Wahl. He advocated that each Section should hold discussions on unity and make surveys to determine their views which should be sent to the Board of Directors. Mr. Wahl cited the statement in the article by President Hooven, *Electrical Engineering*, May 1956, page 405, to the effect that the Board awaits an expression of opinion from the membership.

Educational and Vocational Guidance

President-elect M. S. Coover, who is a member of the Committee on Education, explained that a number of sessions have been sponsored on the upgrading of curricula in electrical engineering. Because time is at a premium, some schools are resorting to tape recording. He referred to a bibliography of text material prepared by Engineers' Council for Professional Development (ECPD) which is to be published. He also stated that during the fall and winter, the Committee on Education is going to sponsor sessions.

Mr. Coover explained that vocational guidance information was difficult to get into the high schools. He suggested that principals and counselors be invited to meetings. In the smaller communities, career days held in the spring were too late. It would be better to hold these in the fall and talk with the juniors and seniors. He drew attention to the ECPD leaflet, "After High School—What?" and "Engineering—A Creative Profession," also an ECPD booklet, which are useful tools to take along when going to a high school for a day. One should take a half-dozen with him and tell the students they are available in the school libraries, he stated.

Group Dynamics

The principles of "group dynamics," which encourage lively participation in a meeting and prevent a few people from monopolizing the time, were explained by Dr. T. A. Jackson of the management consultant firm of Stevenson, Jordan and Harrison, Inc. "Group dynamics" begins with small groups of seven or eight people who, in 10-minute buzz sessions, determine the most important topics to be discussed. These are put on the blackboard and comprise the agenda for the meeting. The chairman calls upon experts or discussion leaders to answer questions about the chosen topics. This is the method of conducting meetings recommended by the management consultant firm which has been retained by the Institute. Dr. Jackson explained that the method could be applied to any kind of meeting and visual aids could be employed. "Group dynamic" principles, which make the meeting more interesting, were likened to the principles of feedback.

The meeting was divided into two sessions: Group A, larger than average sections and Group B, smaller than average sections. Among the topics selected by the buzz sessions in Group A were the following: (1) attendance at meetings; (2) unity in the engineering profession; and (3) vocational guidance in the high schools.

Referring to the first topic, Prof. Harness, chairman of the Los Angeles Section, explained that as the Section grew, groups were organized on communication, basic sciences, young engineers, etc., with good results. To avoid the post college slump which takes place a young engineers group was created. Local dues of $2 were solicited with a 55–60 per cent return realized because of envelopes enclosed for convenience.

In reference to unity, Past-President E. B. Robertson explained that in comparing the federation type of organization versus the National Society of Professional Engineers (NSPE) type of organization, the Institute believed in an organization of individual members with individual dues. Electrical engineers would like to be held in the same esteem as medical doctors. It was further explained that the Board would hold a two-day meeting to consider this important problem. In conclusion, Mr. Robertson explained that the organizations of the legal and medical professions were practically of the same type. A question was raised as to whether the group would be willing to pay for all this as the American Manufacturers Association (AMA) costs ranged from $45 a year to a maximum of $115, and that it would not be possible to get something for nothing. Mr. Robertson said that he would like to see the Institute support ECPD, serve Engineers Joint Council (EJC) with its objectives specifically defined, and believed that NSPE offered the best opportunity for organization on a county basis.

The ways to handle vocational guidance in the high schools were explained by W. B. Morton, chairman of the Committee on Student Branches. Interest should be started below the senior high school level by arousing interest not only in the youngsters but the parents. He hoped to have a program which would lay as high emphasis on the pre-high-school level as in the later years. President-elect Coover suggested 15-minute radio and television programs directed to high school students. These programs can be very effective if arrangements can be made for producing them.

The conference was continued in the afternoon dividing into Groups A and B, and employing the principles of "group dynamics." The topics decided upon for discussion were as follows: (1) increasing Section allotment; (2) reducing red tape on membership and making pertinent information available; (3) AIEE-Institute of Radio Engineers relations at the Section level; (4) time payments for initiation fees and dues; (5) financing sections: local dues, local members, and others; (6) increasing student interest; and (7) transferring associates to member at the section level.

Reasons why many of these proposals were not practical were explained by chairmen and members of the respective national committees. In regard to increasing the Section allotments, the conference voted to request the Sections Committee to ask the Board of Directors to study increasing the Section allotments within the next year.

New Subsections

No new Sections have been organized, but the following new subsections were reported: Blue Ridge Subsection of Virginia; Eugene Subsection of Portland; New London Subsection, Merrimack Valley Subsection, and Cedar Subsection in the Iowa area.

Public Relations Workshop

The objectives of good public relations and the methods of attaining the desired results were outlined by Fischer Black (chairman of the Public Relations Committee), President Hooven, and R. C. Mayer, Jr.

Mr. Black cited as objectives acquainting the community with the importance of the electrical engineer and the AIEE as a professional society, and of conveying engineering philosophy to the general public. President Hooven stated that public relations was a duty to the community. The public should recognize the importance of engineering as a profession so that the smart young minds can be directed into the profession. Mr. Mayer gave some of the prime factors for good public relations which he likened to a way of life the art of not treating the public like relatives. He urged simplicity in carrying out public relations from day to day. In respect to newspapers, be sure the story is news, that it goes out on time, and is in the proper form. He also suggested that Section public relations committee activities be planned well in advance with a vice-chairman and with men who have had experience with public relations in industry.

Technical Groups in the Sections

A group dynamics type of meeting in the evening session led to a discussion of the following: (1) technical groups versus Section meetings; (2) need for group dynamics; (3) technical groups in the small Sections; (4) administration relationship to Sections; (5) aid from the Divisions; and (6) conference type meeting versus the formal speaker type meeting. Each topic was detailed and,

Bimonthly Publications

The bimonthly publications, *Communication and Electronics*, *Applications and Industry*, and *Power Apparatus and Systems*, contain the formally reviewed and approved numbered papers presented at General and District meetings and conferences. The publications are on an annual subscription basis. In consideration of payment of dues, members (exclusive of Student members) may receive one of the three publications; additional publications are offered to members at an annual subscription price of $2.50 each. Nonmembers may subscribe on an advance annual subscription basis of $5.00 each (plus 50 cents for foreign postage payable in advance in New York exchange). Single copies, when available, are $1.00 each. Discounts are allowed to libraries, publishers, and subscription agencies.

with reference to these points, Dr. Jackson suggested that success should not be determined by attendance but by the number participating. As explained by L. F. Hickernell, the need arose from a survey indicating a type of meeting in which young members could take part. Each division would have a technical guidance committee. No change is contemplated, and each technical group will be administered by the Section. The view was expressed by Past-President Robertson that better papers might result as the groups might prepare discussions. Director A. C. Muir pointed out that 3,000 technical committee men comprised 6 per cent of the Section membership and they might be able to pick people who should be members of the technical groups.

In respect to the conference type of meeting versus the formal speaker type of meeting, Dr. Jackson believed that both types of meetings could be maintained.

65 Technical Sessions Held at San Francisco Meeting

THE 65 TECHNICAL SESSIONS of the AIEE Summer and Pacific General Meeting, June 25–29, San Francisco, Calif., covered a wide variety of subjects and was of great interest to the members and guests. That the papers were well received and timely was evidenced by the many discussions that followed each presentation. Several of the speakers increased the value of their papers with demonstrations and visual aids. All are to be congratulated on the efforts which went into the preparation and presentation of the papers.

Domestic and Commercial Applications. An outstanding session was arranged Tuesday morning by the Committee on Domestic and Commercial Applications. The papers pertained to the heating of homes by electrical means and the effect on the utilities supplying the power. S. L. Forsyth, Westinghouse Electric Corporation, in his paper, "The Influence of Practical Considerations on the Use of Electric Heating of Homes," showed why it is advantageous to heat homes electrically from the viewpoint of the home owner as well as the utility supplying the power. He stated that the revenue increased 82 per cent on the average (from $123 to $234) for those houses in which electric heating had been installed. Furthermore, "heating" loads are very little more than "cooling" loads at present, because of the increased use being made of air-conditioning units throughout the country.

Regarding the cost of an electric-heating installation, it has been found that if the power is available at 1.5 cents per kw-hr, electricity can compete with fuel oil selling at 16 cents per gallon. The speaker also brought out that the "use efficiency," i.e., the proportion of the energy supplied that is actually used to create comfortable surroundings, is higher with electric heating than with a central heating plant.

In a survey, it was found that the unit heater system ranked first. This system is one designed to heat one room independently of all others.

J. C. Beckett, Wesix Electric Heater Company, spoke on the economics of resistance heating. He discussed the architectural changes in the last 10 years and how they have changed the thinking of designers of heating installations. Utilities' distribution problems differ widely throughout the country, but the energy requirements are easily calculated.

Instruments and Measurements. At the opening session of the Committee on Instruments and Measurements Monday morning, C. F. Savage, Jr., of the General Electric Company presided. The first paper presented was "VIAC: A Variable Interval Automation Controller" by J. R. Wood, M. L. Klein, and H. C. Morgan, all of North American Aviation, Inc. The VIAC, constructed of commercially available parts, was devised to control the actual running time of the recording system so that only those times of particular interest would be recorded, thereby conserving paper and still obtaining all vital information.

In his paper, "Accurate Measurement of Phase Shift at Low Audio Frequencies," W. M. Meier of Westinghouse Electric Corporation described a "resolver-substitution" test set capable of measuring phase shifts at frequencies of the order of 50 cycles to an accuracy of about ±0.2 degrees. The instrument, extremely simple to operate, is immune to harmonic distortion which does not exceed approximately 5 per cent.

"Precise Determination of the Watt-Hour," by L. E. Janetos and J. J. Hall of the General Electric Company, was presented by F. H. Busch. The paper discusses the substantial improvements which have been made in the last 15 years in the precise measurement of watt-hours. Today it is possible to derive a value of the watt-hour that is reproducible from month to month within ±0.04 per cent at unity power and ±0.07 per cent at 0.50 lagging power factor.

A Tuesday afternoon panel discussion, also sponsored by the Committee on Instruments and Measurements, was concerned with nuclear instrumentation. Lester Kornblith of the General Electric Company presided. Worrell Deuser of the University of California discussed techniques involved in the millimicrosecond type of counting. Several types of cable being utilized in this work were demonstrated. G. R. Wilde of the Hanford Engineering Works described the Hanford water-cooled reactor, which basically consists of stacked piles of graphite with columns of uranium slugs. The power calculating system, reactor control system, pressure monitoring system, and temperature monitoring system were also described. Norman Wilson of the Pacific Gas and Electric Company outlined a number of the instrumentation requirements for pressurized water-cooled reactors. Ivan Jacobs of the General Electric Company discussed the use of neutron monitors for nuclear power plant safety.

Land Transportation. Three papers were presented at a Tuesday morning session sponsored by the Committee on Land Transportation. E. A. Foster of the Foster Engineering Company, Chicago, Ill., presided. J. G. Inglis of the Toronto Transit Commission presented a paper covering rapid transit progress in Toronto, where Canada's first subway system was opened in 1954. The success of the subway has caused municipal authorities to reconsider the order of priority between future expressways and subway lines.

S. D. Forsythe, Chicago Transit Authority, presented his paper, "Rapid Transit Expands in Chicago," describing the work which has been done and is currently projected for improving rapid transit in Chicago, Ill. Mr. Forsythe stressed the new trend toward incorporating rapid transit into urban highway plans. This possibility of combining automotive traffic and rapid transit traffic is being given active consideration in connection with every expressway that is being planned for the Chicago area.

A paper by S. M. Shockey of the Seattle Transit System (page 792 of this issue) discusses the adaptation of a trolley coach system to a changing traffic pattern.

At the Tuesday afternoon session, E. C. Wrausmann, St. Louis Car Company, described some of the latest developments in the design and construction of cars for rapid transit. He stressed the need for rapid transit facilities in this country's expanding communities and told how the car designers and operating companies were instrumental in incorporating new ideas in cars.

C. M. Hines of the Westinghouse Air Brake Company stated that brakes for modern rapid-transit cars had been improved greatly because of the cars' increased acceleration and velocity. Both dynamic and air brakes are being used today. After explaining the functioning of air-brake equipment, he told how composition shoes instead of those made from cast iron had been found to be better and were being used today.

In a paper describing the first year's experience with new control equipment on New York City's subway cars, G. W. Weber, General Electrical Company, said that only a few easily replaceable parts are needed annually in the control. In discussing the cars' uses, he stated that over 500,000 cycles of operation annually were estimated on a control, yet the wear rate and arc-erosion rate was such that there was no need for lubrication, adjustment, or yearly overhaul. There is now a 10,000-mile inspection, but it is anticipated that a 15,000-mile inspection will become more common in the future.

Management. Three conference papers were delivered at the session sponsored by the Committee on Management. The first of these, "Organizing to Build the Commonwealth Edison Nuclear Power Plant," was given by J. E. Maider of the Commonwealth Edision and General Electric Companies. After tracing the development of the proposed plant, he told how the Atomic Energy Commission had granted its permission for the plant's construction in 1955; it is to be finished four years hence.

It was felt that the Commonwealth project personnel should be later integrated into the General Electric organization. The present engineering organization is divided into the following: design engineering, technology, administration, and project engineering. The heads of each of these departments report to a manager. The design engineering personnel provide plans and policies, handle the engineering design for the reactor and its associated equipment, provide the purchase specifications, specify and evaluate tests, and prepare hazard reports. The technology group provides fuel specifications, research and development, technical assistance, and radiation engineering service, and participates in the reactor's start-up. Those in the administrative group provide contracts, process technical papers, act as landlord, prepare test procedures, and develop techniques and methods. The project engineering personnel are in charge of design, manufacturing, and construction of the plant.

In the discussion, it was brought out that not all the personnel had security clearance, inasmuch as there were phases of the work which did not demand it. One of the problems involved is training new men for jobs because it is impossible to keep the same men on the same job for five years. Unless employees can be advanced, incentive is lost; on a project of this nature, such a situation is unthinkable.

Glen Ireland, Pacific Telephone and Telegraph Company, presented a history of the development of the management-conference method of training for those in line for executive position. In 1954, a two-week course was started for supervisors, and since then, over 3,000 have taken this training and said it was beneficial. Now an interarea one-week series of conferences has been tried with 48 men being trained at a time.

There are also courses for top executives, among them being a 10-month course at the University of Pennsylvania.

In the discussion, it was asked what percentage of the trainees were engineers; the answer was about 20 per cent. It was also brought out that the idea is to develop individuals' thinking and not to cram ideas into a man.

The final conference paper of the session was "How an Engineering Education Fits an Individual for a Management Position," by G. C. S. Benson, Claremont Men's College. It was read by H. H. Grant, chairman of the session. The paper points out that many engineers are heading companies because the companies' products are scientific in nature; they are used to making things work and so are used to making decisions. However, most college engineering programs are lacking in courses in the humanities, money, banking, labor relations, etc., which should be given late in the college course when the students are better able to visualize their later responsibilities.

Wire Communications Systems. At a session sponsored by the Committee on Wire Communications Systems and devoted to subscriber carrier systems, T. J. Fleming presided. A single-sideband subscriber carrier system was the subject of papers by W. E. Noller and G. L. Curtis, both of Lynch Carrier Systems, Inc. Mr. Noller's paper discusses some of the design and equipment parameters that were considered in the development of *B120* subscriber carrier. The paper by Mr. Curtis describes some of the application problems encountered with subscriber carrier installations.

A paper by Elvin Krasin of the Panhandle Electrical Construction Company, Amarillo, Tex., describes the use of frequency modulation as an economical approach to the utilization of higher carrier frequencies for subscriber carrier systems.

The type-*P1* carrier system, a fully transistorized two-way rural system, was discussed in a paper by R. C. Boyd and E. H. Perkins of Bell Telephone Laboratories, Inc. The *P1* system, which operates economically on rural open-wire lines, provides a flexible facility for adding a number of subscriber channels to an existing rural line with a minimum of line treatment.

A paper by B. R. Stachiewicz, R. L. Layburn, and D. F. Jamieson, all of the Stromberg-Carlson Company, outlines the features of a system designed to permit the use of five carrier channels over the available rural lines without the necessity of any modifications in the existing central-office equipment.

Education. An interesting panel discussion on the problems of getting young engineers from college into industry was under the sponsorship of the Committee on Education. H. H. Skilling of Stanford University presided.

D. I. Cone of the Pacific Telephone and Telegraph Company reviewed the history of the engineering manpower situation from the early days of the depression to the present time, with emphasis on today's "feverish indiscriminate scramble" for young engineers. W. R. Hewlett of the Hewlett-Packard Company discussed the importance of stressing basic sciences courses in college rather than "how to do it" courses. He believes that it is the responsibility of industry to set up training programs which will concentrate on the specific problems of the company involved. J. M. Cage of Purdue University spoke from the viewpoint of the professor who must guide students on placement. The necessity for educators to keep up with industry's changing personnel requirements was emphasized.

R. O. Brosemer of the General Electric Company described the operation of several of General Electric's training programs, as well as the philosophy behind these programs. He also touched on the professional growth of the engineer in industry. J. C. Beckett of the Wesix Electric Heater Company discussed some of the problems of a small company in obtaining and utilizing engineering talent. One solution to the problem is the use of students, on a part-time basis, for a portion of the company's research work. W. R. Johnson of the Pacific Gas and Electric Company spoke on the operation and features of co-operative programs offered by a number of engineering schools. M. S. Oldacre of the Stanford Research Institute reported some of the significant findings of an opinion survey conducted among a large sample of this year's electrical engineering seniors.

Several of the points which industrial managers should keep in mind when hiring and training technical personnel were outlined by R. M. Saunders of the University of California. Among these points were the following: (1) it is important that management keep up with the speedy educational evolution taking place; (2) present graduates are imbued with the idea that their education has just begun; (3) young engineers expect and demand a professional climate; and (4) compensation and security are secondary.

Television and Aural Broadcasting Systems. At the Wednesday afternoon session sponsored by the Committee on Television and Aural Broadcasting-Systems, the first paper was given by F. H. McIntosh, a consulting radio engineer, on a 60-watt audio amplifier he developed. He discussed the power of different musical instruments and the severe power requirements they impose on an amplifier, as the peaks occur near the middle frequencies more often than at the lower and upper limits. He also discussed "room gain"—about 15 db—in home rooms; the design and size of loud-speaker diaphragms and their relationship to the size of rooms. He demonstrated his amplifier with recordings of a thunderstorm, sounds of a subway train, piano music, etc.

A. P. Walker, Association of Radio and Television Broadcasters, spoke on the remote control of directional and high-power standard broadcast stations. In the three years that the Federal Communications Commission has permitted the remote control of FM transmitters, the outage time has been less than one per cent in stations of all power outputs. Technical standards of remote-controlled transmitters have been upheld and there have been no personnel layoffs.

G. H. Brown and C. N. Hoyler of RCA Laboratories presented a lecture-demonstration showing the effects of recent studies in color television. Dr. Brown told about the studies in uhf-band propagation from the Empire State Building antennas.

At a Thursday morning session devoted to television, four papers were presented. A paper by E. D. Barcus and A. E. MacMahon of the Pacific Telephone and Telegraph Company, and presented by Mr. MacMahon, described the details of the complex television networks planned for the Republican Convention in San Francisco, Calif., in August.

"Color Kinescope Recording on Embossed Film," by C. H. Evans and R. B. Smith of the Eastman Kodak Company, outlines a new technique by means of which color kinescopes may be made on embossed 35-mm film with a black-and-white emulsion. The method is advantageous in that short time requirements can be met.

P. T. Sproul of Bell Telephone Laboratories, Inc., explained the features of a newly developed video visual measuring set operated with sync pulses. This test set is designed to make gain-frequency measurements of a video transmission circuit over the range of 100 kc to 10 mc, and to present the characteristic on an oscilloscope.

In the final paper of the session, A. G. Sparling of Stations KHQ-AM and TV, Spokane, Wash., discussed some of the problems of vhf propagation over rough terrain.

In a Thursday afternoon session, E. L. Michaels, Hughes Aircraft Company, gave an excellent talk on basic colorimetry for color television. After describing the fundamentals of color, i.e., luminance, chrominance, radiance, primaries, and complementaries, he explained the fundamental rules of colorimetry and its important ratios. He then explained the derivation of the chromacity diagram from the color cube.

Carrier Currents. One of the more interesting papers in the session on carrier currents was that given by W. C. Feaster, Potomac Edison Company, and E. E. Scheneman, Westinghouse Electric Corporation, "Application of Transistors in Power Line Carrier Relaying." Mr. Scheneman, who read the paper, told about laboratory experiments which were begun in 1952 and the field tests dating from December 1953. After a series of tests showed the feasibility of the equipment, a 132-kv circuit, 12 miles long, was selected for an installation in which transistors replaced vacuum tubes. The carrier frequency was 70 kc, the circuit attentuation was 6 db, and the receiver relay current was 18.3 milliamperes. This equipment functioned continuously with no significant change from June until November 1955, when the point-contact transistor oscillator failed. A new oscillator using two junction-type transistors instead of the point contact type was installed, and the sets operated satisfactorily for more than three months. It was concluded that the transistors show a better life than tubes, which have an average life under these operating circumstances of about 14,000 hours.

Radio Communications Systems. R. D. Campbell of the American Telephone and Telegraph Company presided at a Thursday afternoon session sponsored by the Committee on Radio Communications Systems. A paper by M. W. Walther and C. S. Watkins of the Pacific Telephone and Telegraph Company discussed the emergency use of microwave radio in northern California particularly in conjunction with the recent floods in that area.

A mathematical analysis of the determination of thin wire loop antenna impedance was presented in a paper by J. E. Storer of Stanford University.

H. Busignies of Federal Telecommunication Laboratories described the principles of TACAN, the new radio air navigation system of the polar co-ordinate type which has been built by Federal for the U. S. Navy and Air Force.

Nucleonics. In the first of two sessions on nucleonics, the 180,000-kw Dresden nuclear power plant of the Commonwealth Edison was described by C. H. Robbin, General Electric Company. This plant, which is to be ready by 1960, has automatic control of the turbine load. One setting of the reactor automatically controls the turbine load and one setting of the reactor's controls operates the reactor's turbine power from 40 to 100 per cent. There are three sets of safety systems.

W. P. Peabody, General Electric Company, described the control and instrumentation of the Dresden reactor which is by subcooling the water.

In the afternoon session on nucleonics, A. J. Stripeika, University of California, discussed the ownership of electronic testing equipment. One way is to have each physicist personally own and be responsible for whatever equipment he might need in his work. Another way is to have ownership rest with a service group, a sort of community property. A third way is a combination of these first two, which is the way it is handled at the Radiation Laboratory. Here the physicists are helped by technicians to care for the equipment and assist in setting up experiments. All the equipment is in one area of about 740 square feet and brought out to patch panels.

Several different arrangements were shown of experimental areas and the 1,700-square foot testing area for the 6 billion volt bevatron. In general, one or two men are assigned to maintenance of testing equipment.

G. H. Strong, General Electric Company, described an apparatus which has been developed to "scram" a reactor. If anything goes wrong with a reactor, it must be shut down in two or three seconds and this is done by dumping a load of 3/8-inch boron-steel balls from a hopper at the reactor's top through the reactor into a hopper at the bottom. These balls must then be transported back to the top of the reactor and this is done by an electromagnetic conveyer.

This consists of $2^1/_4$-inch stainless-steel pipe which is surrounded throughout its length by a series of coils of wire. Four-phase current energizes the coils and this creates a traveling flux, 180 degrees out of phase. This flux is sufficiently strong to cause the balls to rise within the pipe up to the reactor's top.

Chemical Industry. The Thursday morning session opened with "Electrical System for a Nuclear Reactor," presented by E. P. Peabody and followed by a question and answer discussion by D. S. Brereton, both of General Electric Company. Their paper gives a very thorough description of the planning and design of the Hanford Atomic Products plant on the Columbia River. They have proved that, with the proper planning, an atomic plant can be predictable and also give a high degree of reliability.

The second paper was C. S. Bucholz's "Cathodic Protection for Steel Retention Tanks Containing Reactor Coolant Water." Mr. Bucholz was concerned with the corrosion problems for the Hanford atomic plant, primarily that of radioactive hot water in steel retention basins. Cathodic protection was used and because of the high resistivity of the Columbia River water, much higher voltages and current densities than that possible with magnesium anodes were required. Three types of anodes were tried. Aluminum was not satisfactory, graphite was heavy and expensive, but duriron gave good results. As a closing point of discussion, it was pointed out that radioactivity does not seem to affect the water resistivity or its corrosion rate.

North West District Activities at San Francisco Meeting

Courtesy C. B. Brown

Courtesy C. B. Brown

Above, *left:* Vice-President J. R. Walker and District Secretary C. B. Brown, of Billings, Mont., and incoming Vice-President M. M. Ewell and District Secretary Howard Arnett, of Portland, Ore., met with incoming section chairmen to discuss plans for future Institute activities in the North West District. This meeting which served to introduce the new district officers to their new section chairmen was held in the Fairmont Hotel, San Francisco, Calif., the first day of the Summer and Pacific General Meeting, June 25, 1956. Seated (*left to right*) are Mr. Arnett; Mr. Ewell; Mr. Walker; and J. D. Fox, Spokane Section. Standing (*left to right*) are C. R. Kingsbury, Seattle Section; A. E. Opdenweyer, Portland Section; R. B. Carter, Vancouver (British Columbia) Section; M. M. Dye, Eastern Idaho Subsection; and R. C. Hoffman, Richland Section. Above, *right:* North West District Student Counselors scored 100 per cent attendance at a meeting of the District Student Activities Committee in the International House on the University of California campus at Berkeley, Calif., June 26, 1956. Prof. F. D. Robbins, chairman of the District Committee, presided at the meeting which was held in connection with the Summer and Pacific General Meeting in San Francisco, Calif. Incoming Vice-President, M. M. Ewell, attended and was introduced to the professors who will guide the sudent branches for the coming year. Seated (*left to right*) are R. E. Stephenson, University of Utah; District Secretary C. B. Brown; Chairman Robbins, University of Washington; L. R. Kersey, University of British Columbia; and L. N. Stone, Oregon State College. Standing (*left to right*) are R. F. Dunford, Montana State College, incoming chairman; Vice-President Ewell; Rev. F. P. Wood, Seattle University; A. L. Betts, State College of Washington; and W. R. Parish, University of Idaho.

The third paper was "Minimizing the Fifth and Seventh Harmonics on an A-C Distribution System" by W. R. Kiltz of The Dow Chemical Company. This paper presented an inexpensive method of bleeding off most of the lower order harmonics generated by a 6-phase rectifier. By using existing capacitor and transformer equipment, the fifth and seventh harmonics were bled off through transformer-capacitor couplings tuned to near resonance and located close to the source of the harmonics. Mr. Kiltz presented simple formulas for determining the approximate sizes of transformers and capacitors required for any harmonic frequency.

The last paper of the session was "Expansion of Electrical Facilities in Chemical Plants Utilizing Existing Switchgear," by H. N. Hickok of the General Electric Company. This paper outlined the application of the following methods for increasing the size and interrupting capacities of existing power facilities: (1) splitting main busses, (2) transformer ties, (3) unit substations, (4) synchronizing bus ties, (5) duplex reactors, and (6) raising system voltage.

At the Thursday afternoon session, the first paper was "The Germanium Rectifier Is Growing Up," by R. M. Grenshaw of the General Electric Company. (See August *Electrical Engineering*, page 718)

"Electric Cable Insulation in Chemical Plants," by J. E. Parker of the Carbide and Carbon Chemicals Company was the most controversial of the day. This was to be expected, as the advocates of underground and of overhead distribution cables are fairly well divided. Mr. Parker's plant uses mostly underground cables and he presented a very thorough case history of their experiences with oil base, neoprene rubber, and polyethylene insulated cables. Although polyethylene insulated cables with polyvinyl chloride jackets proved most satisfactory in hydrocarbon and chemical environments, this type of cable is by no means a "cure all." Its usage is questionable at voltages of 15 kv and higher. In the discussions following Mr. Parker's paper, B. J. Nankervis of The Dow Chemical Company voiced his opinions in defense of overhead cables. All participants agreed, however, that both types of distribution cables had their advantages and disadvantages.

Mr. Nankervis also presented the next paper, "High Voltage D-C Listing of Cables and Cable Fault Locations." In the Gulf Coast plant in question, all of the 13.8-kv distribution is with overhead 15-kv varnished cambric insulated cables with nonmetallic jackets and armor over all. During service, all cables are periodically tested and a case history of each cable is kept on file so that failures can usually be anticipated. Normally, leakage currents decrease during the five minute test period. If it increases, then trouble is expected. Power factor tests are not considered as a good test, except after a fault has been found. The location of faults are preferably found by patrolling the lines; however, other methods may be required. These may be by use of kenotron test set, by condenser air gap test set, or simply by burning the fault for visual signs of smoke. Before any cable test is made, however, proper safety precautions are taken to protect both personnel and equipment.

The last paper was "Corona in Metal Clad Switchgear" by H. O. Borque of the Ethyl Corporation. This Gulf Coast plant like many other seacoast installations has atmospheric conditions which promote corona. In most air, nitrous and nitric acids are formed which attack insulations and switchgear parts. Equipment and cable manufacturers combat these detrimental agents by such means as eliminating sharp corners and bends, filling air voids, providing ample clearances, and using shielding tapes and semi-conducting paints. Corona can also be kept to a minimum by periodic cleaning, preventative maintenance, and also by keeping the switchgear warm and dry. Four types of insulating materials were tested: (1) phenolics, (2) phenolic impregnated paper, (3) phenolic impregnated wood, and (4) polyester paper. The phenolic impregnated wood proved best in the corona test. Although conclusive tests had not been run, it is believed that polyester glass may be superior to any of the tested materials.

AIEE Board of Directors Summer Meeting Held June 28–29

THE BOARD OF DIRECTORS of the AIEE held a two-day meeting in San Francisco, Calif., during the Summer and Pacific General Meeting of 1956. The unusually heavy agenda required the full days of June 28–29. Of the 35 officers eligible to attend the June Board Meeting, 33 were present. Since this Board Meeting follows the Annual Meeting of the Institute, the newly elected Vice-Presidents and Directors traditionally are included. It is also normally the last Board Meeting of the administrative year.

One of the major topics before the Board was "Intersociety Relations." The Board spent the greater part of one day in session as "A Committee of the Whole" for the purpose of informal exploration of policies, practices, trends, and opinions relative to the numerous complex associations with other organizations through which, in part, AIEE functions and serves its membership. After these exploratory sessions, the Board appointed a Drafting Committee to prepare, for future Board consideration, a statement of AIEE objectives and policies in the field of Intersociety Relations.

The 1962 Summer General Meeting was set for June 18–22, in Denver, Colo. A change in the location of the 1957 Pacific General Meeting was authorized, providing that it shall be held in Pasco, Wash., August 28–30, 1957 instead of Yakima as previously planned. A complete schedule of future General and District Meetings will be found in this issue of *Electrical Engineering*, page 861.

On recommendation of the Committee on Planning Co-ordination, the Board of Directors approved a plan of reorganization for the Institute, the major effect of which is the grouping of the General Committees into four "Departments," similar to the present Committee on Technical Operations (CTO) in its relation to the Technical Divisions and Committees. In fact, the CTO becomes one of the five new Departments, which will be known as the Administration Department, Admission and Advancement Department, Publication Department, Professional Development and Recognition Department, and Technical Operations Department. The Finance Committee, Constitution and Bylaws Committee, and Planning and Co-ordination Committee retain approximately their past relations to the Board of Directors. The Chairmen of the Five Departments will attend meetings of the Board of Directors and participate in the deliberations, except for voting on formal actions of the Board. The organization chart, approved by the Board of Directors as a guide to the Bylaw Amendments necessary for implementing the plan, is published on pages 858-9.

It is the intent of these organizational changes to delegate to the Five Departments authority for operating the Institute's major functions according to policies prescribed by the Board of Directors. It is the expectation that the Board of Directors will be able to devote itself more effectively to its policy-making function.

The Constitution and Bylaws Committee, in addition to presenting the Bylaw Amendments necessary to implement the new organization plan, also offered a new version, completely rewritten and restyled of that part of the Constitution and Bylaws applying to Student members and Student Branches. The new style Bylaws were enthusiastically approved by the Board of Directors and the Committee was requested to continue its project until the whole of the Constitution and Bylaws has been given a new format and new editorial style. The project also includes bringing these two basic documents up-to-date, and eliminating from them detailed operating rules and instructions.

Two new Affiliate Student Branches were approved: at the University of Alaska located in College, Alaska, and at the University of Miami in Coral Gables, Fla.

The Board accepted the auditor's report for 1955–56, after which the Treasurer reported that as of May 31, 1956, the General Fund contained a balance of $284,306.52, as against $31,702.11 last year at the same time. The difference is chiefly the result of the increase of dues.

Acting on recommendations from the Board of Examiners, the following additions to the membership of the Institute were effected: 17 Fellows, 282 Members, 742 Associate Members, 104 Affiliates, 803 Student members.

Dean M. S. Coover resigned as a Director of the Institute, effective August 1, 1956, on which date he became President. To fill the vacancy thus created on the Board of Directors, C. H. Linder, vice-president, General Electric Company, was elected a Director for the unexpired term ending July 31, 1957. A biographical sketch introducing the new Director will be found in this issue of *Electrical Engineering*, page 836.

President-elect Coover presented to the Board for information and confirmation, where required, a complete list of the General Committee appointments for 1956–57. Also included with these lists were appointments of representatives to various Intersociety activities.

Director-elect L. M. Robertson, one of the three representatives of AIEE on the Special Task Committee to select a site for the new Engineering Societies Center Building, presented the Report of the Task Committee, which had been released two days prior to the meeting of the Board. The essential features of the Report of the Special Task Committee are contained in a news item in this issue of *Electrical Engineering*, page 836. The Board of Directors received the report, and referred it to the individual members of the Board for study and consideration with the anticipation that the recommendations contained therein would be acted on at the next meeting of the AIEE Board of Directors.

The next Meeting of the Board of Directors was set for August 17, 1956 in New York, N. Y. It is anticipated that future meetings will be held, as usual, in connection with the Fall and Winter General Meetings, and possibly one of the District Meetings in the spring of 1957.

Special Task Committee Reports on New Engineering Societies Center

THE FOLLOWING is the report of the Special Task Committee of the Founder Societies and AIChE concerning a location for the Engineering Societies Center which was presented to the AIEE Board of Directors at their meeting held June 28–29, during the Summer and Pacific General Meeting.

To the Governing Boards of:

American Society of Civil Engineers (ASCE);

American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME);

American Society of Mechanical Engineers (ASME);

American Institute of Electrical Engineers (AIEE);

American Institute of Chemical Engineers (AIChE)

We have completed our assigned task and make these recommendations on the location of the new Engineering Societies Center:

Item 1—The Engineering Societies Center be located in New York City.

Item 2—The 39th–40th Street site be continued in use as the site of the Engineering Societies Center.

If rebuilding in that area proves impracticable, a comparable site should then be sought in midtown New York.

We suggest that the Governing Boards also adopt these further recommendations for inaugurating action:

Item 3—The United Engineering Trustees, Inc. (UET), be authorized to take proper legal action for expansion by the addition of the American Institute of Chemical Engineers to the incorporators when properly qualified.

Item 4—The United Engineering Trustees, Inc., be authorized to raise money and accept contributions; accept the offer of the Kelly Committee; place contributions in UET Capital Fund Assets; employ architects, engineers, and attorneys; let contracts for reconstruction of the present Engineering Societies building and/or a new building or buildings; pay all costs out of the Capital Fund Assets; and operate and maintain the new Engineering Societies Center.

Item 5—The plans for the new and enlarged Engineering Societies Center be made with ample optimism with respect to the future growth of the five societies immediately involved. These facilities should be such as to attract and hold all of the Engineering Profession, thus fostering unity and co-operation along broad lines.

The vote of the Special Task Committee, the members of each of the five Societies voting as a unit as prescribed, is unanimously in favor of these recommendations.

We are submitting a detailed report, prepared in collaboration with our consultants—McKinsey and Company. We are prepared to discuss our findings, conclusions, and recommendations with you at your request. Upon your acceptance of this report, we will consider our assignment completed and request that this Special Task Committee then be discharged.

(*signed*)

AIEE: E. S. Fields, Cincinnati Gas and Electric Company; L. M. Robertson, Public Service Company of Colorado; J. E. Housley, Aluminum Company of America

AIME: H. D. Smith, consulting engineer; Harold Decker, Houston Oil Company of Texas; C. E. Williams, Battelle Memorial Institute

ASCE: F. A. Marston, consulting engineer; R. B. Wiley, Purdue University; M. G. Lockwood, Lockwood and Andrews

ASME: E. G. Bailey, Babcock and Wilcox Company; J. W. Parker, consulting engineer; J. M. Todd, James M. Todd and Associates

AIChE: B. F. Dodge, Yale University; T. H. Chilton, E. I. du Pont de Nemours Company (Inc.); R. P. Kite, Dorr-Oliver Company

C. H. Linder Named Director of the Institute

The Board of Directors of the AIEE has elected C. H. Linder (M '54), vice-president, engineering, General Electric Company, New York, N. Y., as a director, N. S. Hibshman, Institute Secretary, announced recently.

Mr. Linder fills the vacancy caused by the resignation of M. S. Coover, Iowa State College, who has been elected Institute president. Mr. Linder's term of office which began August 1, 1956, will expire July 31, 1957.

Mr. Linder, a resident of Scarsdale, N. Y., has been with General Electric Company since his graduation from the University of Texas with a master's degree in electrical engineering.

He was made manager of engineering and manufacturing for the affiliated manufacturing companies department of the Company in 1950. When the major appliance department was established in 1951, he was named general manager. He was elected a vice-president in 1953.

Mr. Linder assumed responsibility for engineering services functions in the company shortly after his promotion. As vice-president he is charged with the establishment and maintenance of the fund of knowledge and understanding needed to insure maximum effectiveness of the engineering function throughout the company.

Conference Papers Open for Discussion

Conference papers listed below have been accepted for AIEE *Transactions* and are now open for written discussion until September 30. Duplicate double-spaced typewritten copies of each discussion should be sent to Edward C. Day, Assistant Secretary for Technical Papers, American Institute of Electrical Engineers, 33 West 39th Street, New York 18, N. Y., on or before September 30.

56-39 **Determination of Stray Load Loss in D-C Machines.** *R. L. Sieron, D. A. Grant*

56-670 **Some Aspects of Tie Line Bias Control on Interconnected Power Systems.** *Nathan Cohn*

56-713 **Vibration in Vertical Pumping Systems.** *J. H. McKendree, L. A. March*

56-774 **A New High-Interrupting-Capacity Low-Voltage Circuit Breaker.** *W. Harold Edmunds*

Preprints may be purchased at 40¢ each to members, 80¢ each to nonmembers, if accompanied by remittance or coupons. Please order by number and send remittance to: AIEE Order Department, 33 West 39th Street, New York 18, N. Y.

New Prize Rules for AIEE Papers

The following are rules for the award of prizes for AIEE Papers which were approved by the Board of Directors on June 28, 1956, superseding those previously in effect.

General Information

In order to recognize and promote the contribution of meritorious papers, the AIEE has established a series of prizes which are available for annual award to members for outstanding papers. All awards are optional, not obligatory, and it is expected that discriminating judgment will be made by each responsible committee. Each prize consists of a sum of money and/or a Certificate of Award. Appropriate recognition will be given in *Electrical Engineering* and the AIEE "Year Book."

Prizes are available on the national level, known as Institute prizes; on the District level; on the Section level; and on the Branch or Undergraduate level.

To be eligible for an award, a paper must have been presented at a qualified technical meeting of the AIEE (Winter, Summer, Fall, or Pacific General Meeting; District Meeting; Special Technical Conference; Section, technical group, or Subsection Meeting; or Branch Meeting), except as provided in Section (*b*) under Institute Prizes.

Any monetary prize will be divided between coauthors and each will receive a certificate. Certificates and checks for awards are prepared at Headquarters under the cognizance of the committee on Prize Awards. An equivalent gift may be substituted for the monetary prize.

To be eligible for any award, the author, or at least one coauthor, of a paper must be a member (any grade) of the Institute and the other coauthors must be members of a professional society of comparable standing. District, Section, and Branch prizes will be limited to papers, one of whose authors is resident or employed within the respective territory. AIEE committee and subcommittee reports are not eligible for prizes.

All prizes will be awarded on the basis of papers presented during the administrative year, nominally August 1 to July 31, except as specifically stated within these rules. The technical excellence of the paper and its value in its field should constitute the primary basis of awarding of prizes rather than the numerical grades assigned by the original reviewers.

Prizes based on competitive presentation may be withheld whenever, in the opinion of the responsible committee, the number of papers is not sufficient to constitute a real competition. Such papers may be included in competition with those presented in the following year.

Institute Prizes

The awarding of the Institute prizes shall be the responsibility of the Committee on Prize Awards, which is appointed annually by the Institute President in accordance with the Bylaws. The Institute prizes will be presented at the regular Winter General Meeting.

The Institute or national prizes will consist of (a) one from each Division, (b) one for papers sponsored by general committees and articles in *Electrical Engineering*, and (c) a Best Student paper.

(a) *Division Papers:*

Only Transactions papers shall be eligible for Division prize awards. There shall be one first prize for each Division consisting of a certificate and $100. In special cases, additional certificates may be awarded at the discretion of the Committee on Prize Awards. All Transactions papers will be considered for Division prizes without formal offering in competition. The awards will be presented at the regular Winter General Meeting.

The Division prizes shall be judged by the Committee on Prize Awards upon recommendation of a Subcommittee on Prize Awards of each of the Divisions.

As an aid to the Committee on Prize Awards, a Subcommittee on Prize Awards shall be appointed by each Division chairman at the beginning of the administrative year and shall consist of not less than three members of the Division. Recommendations for Division prizes for papers presented during the administrative year shall be submitted by this Subcommittee to the Committee on Prize Awards not later than September 1 of the following administrative year.

To assist the Divisional Subcommittee on Prize Awards, each Technical Committee Chairman is urged to submit nominations for the National Prizes to his Divisional Subcommittee on Prize Awards, accompanied by a brief statement giving reasons why each paper is worthy of consideration.

(b) *Papers Sponsored by General Committees and Articles in Electrical Engineering:*

To encourage the authors of papers sponsored by general committees, and authors of articles in *Electrical Engineering*, an additional prize consisting of a certificate and $100 has been set up. All such papers will be considered for this award if submitted in triplicate to the Institute Secretary before July 31 of the administrative year and accompanied by a written statement as to why it is of prize caliber.

(c) *Best Student Paper:*

A Best Student Paper award also is included among the Institute awards. This consists of a certificate and $100. All student papers which have won a prize in Branch or District student competition will be considered for an Institute award if submitted in triplicate to the Institute Secretary before July 1 of the administrative year in which presented and accompanied by a written statement as to when and where presented.

District Prizes

The awarding of District prizes shall be the responsibility of the Committee on Award of District Prizes which shall be appointed annually by the District Vice-President and shall consist of not less than three Members or Fellows of the Institute. Judges of oral presentation of Student papers need not be the same as judges of written presentation, and they may include Associate or non-Institute members when necessary. The District prizes will be presented at a meeting within the District or at some other meeting upon approval of the District Executive Committee.

The District Prizes comprise (a) a best paper prize for any *Transactions* paper prepared by a resident of the District consisting of a certificate and $75, and a second prize consisting of a certificate and $50; and (b) a best paper prize presented to an undergraduate Student member in district competition consisting of a certificate and $25, and a second student prize consisting of a certificate only.

(a) *Best District* Transactions *Paper:*

All *Transactions* papers presented during the administrative year, nominally August 1 to July 31, will be considered for District prizes without formal offering in competition. *Transactions* papers selected by Technical Committees of the Divisions and the General Committees for consideration as Institute prize papers will be classified according to District allocation, as determined by the residency of the author or authors. In the case of member coauthors from more than one District, a *Transactions* paper shall be eligible in all such Districts. A list of these *Transactions* papers for each District shall be forwarded by the Headquarters staff to the District Secretary for consideration as the District prize papers. In addition to these papers, each District may include for consideration as District prize papers, any eligible *Transactions* paper, whether or not it is among those called to their attention by Headquarters. A paper is eligible to receive both Institute and District prize awards.

(b) *Best Student Paper:*

The District Student Prize Papers competition is limited to papers which have received first prize in a Branch competition.

Section Prizes

The awarding of Section prizes shall be the responsibility of the Committee on Section Prizes which is appointed annually by the Section chairman and shall consist of not less than three Associate Members, Members, or Fellows of the Institute.

Prizes also are available for papers presented by Section members, but because of the wide variation in the character of the Sections, no very definite rules are provided. A sum of $100 is available for each Section to be divided at the discretion of the Section, but with a maximum of $50 for any one prize and a certificate for each winner. When three or more papers are submitted for competition to the Secretary of the Section, arrangements shall be made for presentation before the Section at a meeting set aside for that purpose and a committee selected to judge the contest.

The award of the Section prize will be made at a meeting of the Section.

Branch (Undergraduate) Prizes

The Committee on Award of Branch Prizes shall be appointed annually by the Student Counselor and shall consist of not less than three Associate Members, Members, or Fellows. When necessary, a non-Institute member may be selected.

Two awards for each Branch are available.

The first prize consists of a certificate and $10 plus an allowance of 13¢ per mile one way for 800 miles or less and 10¢ per mile one way for the remaining distance to the district student prize paper competition. The second prize consists of a certificate. When three or more papers are submitted to the secretary of the Branch, arrangements shall be made for presentation before the Branch at a meeting set aside for that purpose and committees selected to judge each such contest.

It is not the primary purpose of Student papers to contribute to the technical advancement of the profession; they should constitute a vehicle for the training and stimulation of future contributors to the profession. To this end, emphasis has been placed on written presentation and the exercise of engineering thinking rather than on technical value. The papers shall be graded in accordance with the following basis:

A. Written Presentation
  Originality—13 per cent
  Survey of subject (analytical procedure)—10 per cent
  Importance—10 per cent
  Appropriateness—6 per cent
  Mode of Expression
    (1) Logical organization of material for clarity, forcefulness, and interest. Appropriate headings are essential (7 per cent).
    (2) Concise and coherent expression of thoughts in good English and with proper choice of words (7 per cent).
    (3) Effective and judicious use of pictorial and graphical presentation (7 per cent).
  Adequate introduction and closure (6 per cent).
B. Oral Presentation
  Speaking technique—12 per cent
  Style (organization of material)—12 per cent
  Introduction and conclusion—5 per cent
  Discussion—5 per cent

For purposes of grading student papers, originality should be interpreted to include credit for (a) individual treatment of the subject by the author and his own mode of expression in writing the paper, and (b) exposition of a technique, apparatus, device, investigation, theory, or analysis that is original with the author. No credit under originality should be allowed for direct copying of other work.

The award of the Student prizes should be made at a meeting of the Branch.

Institute and District prizes for Student papers are also provided as indicated under Institute Prizes (Section *c*), and District Prizes (Section *b*).

Effective Date of Rules

These rules became effective with the administrative year beginning on August 1, 1956.

Procedure for Revision

These rules for prize awards are subject to revision by the Board of Directors of the Institute.

Conference To Be Held on Magnetism and Magnetic Materials

The second Conference and Exhibit on Magnetism and Magnetic Materials will be held in Boston, Mass., at the Hotel Statler, October 16–18, 1956.

The Conference is sponsored by the AIEE in co-operation with the American Physical Society, the American Institute of Mining, Metallurgical, and Petroleum Engineers, and the Institute of Radio Engineers. In addition to the program of technical papers, the meeting will feature exhibits by leading manufacturers of magnetic materials and associated equipment. At a dinner to be held on October 17 at the Museum of Science, Dr. R. M. Bozorth will speak on his trip to the USSR to attend the recent conference on magnetism.

Approximately 75 technical papers will be presented during eight sessions held on the following subjects; magnetic anisotropy, permanent magnets and fine particles, magnetism and physical metallurgy, losses in soft magnetic materials, ferrites, high frequency phenomena, switching devices and magnetic amplifiers, and apparatus and design.

Included in the technical program will be a selected number of invited speakers: H. P. J. Wijn; J. H. Van Vleck, "A Survey of the Theory of Magnetic Anisotropy;" R. M. Bozorth, "Magnetic Annealing;" T. O. Paine, "Fine Particle Magnets;" C. Zener, "Magnetism and the Constitution of Metals;" J. Goodenough, "The Origin of Losses in Magnetic Materials;" N. Bloemberger, "Fundamentals of Ferromagnetic Resonance;" C. L. Hogan, "Microwave Applications of Magnetic Materials;" R. L. Conger, "High Frequency Effects in Magnetic Films;" and T. Bonn, "The Ferractor."

Members of the Conference Committee are R. M. Bozorth, Bell Telephone Laboratories, Murray Hill, N. J., Conference chairman; T. O. Paine, General Electric Company, West Lynn, Mass., local Conference chairman; C. P. Bean, General Electric Research Laboratory, Schenectady, N. Y., program chairman; and R. Rimbach, Richard Rimbach Associates, Inc., manager of exhibits.

The complete program will be published in the October issue of *Electrical Engineering*. Abstracts of the technical papers will be available before the meeting.

Herbert Hoover, Jr., To Receive 1956 Hoover Medal

The Hoover Medal for 1956, one of the engineering profession's most distinguished honors, will be presented to Herbert Hoover, Jr., Undersecretary of State.

The Hoover Medal was named after former President Herbert Hoover, father of the Undersecretary and its first recipient in 1930. It was awarded then, as it has been through the years, ". . . by engineers to a fellow engineer for distinguished public service." It is sponsored by four major engineering organizations, the AIEE, American Society of Civil Engineers, American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME), and American Society of Mechanical Engineers.

Announcement that Mr. Hoover, Jr., had been named by the Hoover Medal Board of Award, consisting of three representatives of each of the four organizations, was made in New York, N. Y., by the Board's chairman, Scott Turner.

Time and place of the presentation to Undersecretary Hoover will be announced at a later date. The ceremony will be under direct sponsorship of AIME, of which he has been a member since 1937.

The Hoover Medal foundation was established in 1929. A statement by the Board of Award relates it was created ". . . to honor engineers whose pre-eminent services have advanced the well-being of mankind and whose talents have been devoted to the development of a richer and more enduring civilization," and that ". . . the engineering societies award the Hoover Medal in recognition and appreciation of those principles and ideals of civic obligation and of public service exemplified by the life and work of Herbert Hoover."

The younger Mr. Hoover's career has been largely in the field of petroleum geophysics. He was graduated from Stanford University in 1925 with the degree of bachelor of arts. He received the degree of master of business administration from Harvard in 1928. He had a teaching fellowship at California Institute of Technology, of which he later became a trustee.

His interest in geophysics grew out of his airlines engineering activities in the West. Mr. Hoover, Jr., became president of United Geophysical Corporation, of Pasadena, Calif. in 1935, and later became chairman of the board. He divested himself of all business interests several years ago when he undertook the assignments in foreign relations that led to his appointment as Undersecretary of State. He has contributed to the AIME technical papers on geophysics; he is a member of the American Association of Petroleum Geologists, and of the Society of Exploration Geophysicists.

The Hoover Medal which Mr. Hoover, Jr., will receive, is gold. On one side it bears a profile of his father. On the other, it is described as an ". . . award by engineers to a fellow engineer for distinguished public service."

Mexico Section Names New Board of Directors

At a recent meeting of the AIEE Mexico Section, the Board of Directors for the coming year was installed as follows: G. S. Payan, chairman of the Board; J. H. Olmedo, vice-chairman; A. W. Gelbke, secretary; V. F. Muñoz, treasurer; Francisco Aubert, chairman—membership;

C. R. Argüelles, chairman—elections; Julio Colón, chairman—public relations; J. M. Malpica, chairman—technical programs; Jorge Lozano y Vea, Finance Committee; D. B. Goldstein, Session Committee; and Manuel Joffe, Members at Large Committee.

At a dinner honoring the incoming officers, Past President Aubert was presented with a certificate in recognition of his work in the organization of various branches of the Mexico Section.

At a subsequent meeting held on June 21, the Section was host to the wives of its members at the American Club.

About 60 members and guests heard Mr. Colón, chairman of publicity, and J. A. Eguía, vice-president of the Grant Advertising Company, speak on publicity and on good will in public utilities.

Royal W. Sorensen Fellows Hold Seventh Annual Meeting

The Seventh Annual Meeting of the Royal W. Sorensen Fellows was held June 6, 1956, at the Oakmont Country Club in Glendale, Calif. President T. M. Blakeslee presided at the meeting and dinner which was attended by 29 Fellows.

The results of the annual election were announced at the meeting. H. L. Caldwell was named president and E. W. Rockwell was elected vice-president–secretary for the 1956–57 year.

Dr. George Harness introduced the speaker, Dr. Eugene Grabbe, senior staff consultant on automation for the Ramo-Wooldridge Corporation. Dr. Grabbe, an international authority on automation, delivered an interesting illustrated talk on the topic, "Computers and Automation."

Dr. Royal W. Sorensen, honorary president of this organization of Los Angeles Section Fellows which was established in 1950, was not at the meeting. He is enjoying an extended European trip.

Fellows in attendance were: E. L. Bailey, W. R. Battey, E. L. Bettannier, T. M. Blakeslee, H. L. Caldwell, W. L. Chadwick, F. H. Cole, Bradley Cozzens, Barry Dibble, J. C. Dow, Fred Foulon, J. M. Gaylord, J. H. Hamilton, G. T. Harness, C. A. Heinze, H. W. Hitchcock, L. F. Hunt, P. L. Johnson, W. N. Johnson, Roy Martindale, M. L. D. McFarlane, E. W. Morris, W. S. Peterson, E. W. Rockwell, E. K. Sadler, M. A. Sawyer, H. P. Sparkes, J. P. Stratford, and J. H. Vivian.

EJC Approves Report On Engineers as Employees

A report entitled "Professional Standards and Employment Conditions," has been approved by the Board of Directors of Engineers Joint Council (EJC).

T. H. Chilton, EJC president, has stated that the report represents the labors of many thoughtful people who have considered and discussed the problems of engineers as employees. A wide diversity of views was to be expected on problems having as many ramifications as these have. The report was finally adopted only after review by the EJC Executive Committee and a Special Task Committee following months of arduous work by EJC's Committee on Employment Conditions.

He continued by saying that it was, therefore, not the work or view of any one individual, and perhaps everyone would find some part of the report with which he could not fully agree. It does, nevertheless, represent a significant appraisal of employment factors which deserve attention. The EJC Board of Directors endorsed the recommendations contained in the report and urged strongly that the constituent societies examine this entire study carefully.

Emphasizing that "there is no simple solution" toward raising professional standards or improving employment conditions of engineers, the Report by Engineers Joint Council makes seven recommendations: (1) management utilize the services of engineers more effectively and, thereby, afford them the opportunity for advancement and economic improvement; (2) management recognize its responsibility to make engineers feel that they are a part of management; (3) management survey areas of communication, recognition, and salaries and, where found wanting, correct them to conform with standards of professional practice; (4) the engineer take inventory of his services and his actions to make sure that he has a professional attitude toward his work; (5) engineering societies establish and employ appropriate means in order to maintain high standards of ethical conduct for professional achievement; (6) engineering societies encourage the professional development of their members and promote proper recognition of the profession; and (7) engineering educators emphasize the characteristics of the profession.

Copies of the "Report on Professional Standards and Employment Conditions" may be obtained without charge from Engineers Joint Council, 29 West 39th Street, New York 18, N. Y.

Dinner Meeting Held by Iowa-Illinois Section

F. D. Newberry of Stanley Engineering Company, Muscatine, Iowa, was elected chairman of the Iowa-Illinois Section of the AIEE at a dinner meeting of the Section held at the Park Lane Country Club, Muscatine.

Other new officers are W. E. Keefe, Bettendorf, Iowa, vice-chairman; C. W. Lauritzen, Rock Island, Ill., secretary-treasurer; and M. P. Roller, LeClaire, Iowa, and E. H. Breckenfelder, Muscatine, Iowa, members of the executive committee.

Mr. Newberry has served as vice-chairman and Mr. Keefe as secretary of the Section during the past year.

The main speaker at the meeting was Gene Stiles, field engineer for Alfred Crossley Associates, Inc., Chicago, Ill. Speaking on "Electronic Instrumentation in Industry," Mr. Stiles explained and demonstrated typical electronic instruments. During his discussion, he explained principles of the various kinds of transducers that are used to convert into electrical signals such variables as temperature, pressure, load torque, etc.

Future AIEE Meetings

Electrical Conference of the Petroleum Industry*
Muehlebach Hotel, Kansas City, Mo.
September 17–19, 1956
AIEE-ISA Instrument-Automation Conference and Exhibit*
New York Coliseum, New York, N. Y.
September 17–21, 1956
AIEE-IRE Industrial Electronics Conference*
Hotel Manger, Cleveland, Ohio
September 24–25, 1956
AIEE-IRE-RETMA-IIT-NU-U of I National Electronics Conference*
Hotel Sherman, Chicago, Ill.
October 1–3, 1956
Fall General Meeting*
Morrison Hotel, Chicago, Ill.
October 1–5, 1956
AIEE-IRE Conference of Magnetism and Magnetic Materials*
Hotel Statler, Boston, Mass.
October 16–18, 1956
AIEE-ASME Combustion Control Conference*
Norwich Inn and Country Club, Norwich, Conn.
October 19, 1956
Machine Tool Conference*
Sheraton Gibson Hotel, Cincinnati, Ohio
October 22–24, 1956
Engineers' Council for Professional Development 24th Annual Meeting
Hotel Statler, Detroit, Mich.
October 25–26, 1956
Farm Electrification Conference*
Memphis, Tenn.
October 29–31, 1956
Fall Textile Conference*
North Carolina State College, Raleigh, N. C.
November 1–2, 1956
AIEE-IRE-ISA Conference on Electronic Technology in Medicine and Biology
Hotel McAlpin, New York, N. Y.
November 7–9, 1956
(*Final date for †TP—closed, ‡CP Syn.—closed, CPMs—Sept. 4*)
AIEE-IRE-ACM Eastern Joint Computer Conference
Hotel New Yorker, New York, N. Y.
December 10–12, 1956
(*Final date for †TP—Sept. 12, ‡CP Syn.—Sept. 26, CPMs—Oct. 5*)
Winter General Meeting
Hotel Statler, New York, N. Y.
January 21–25, 1957
(*Final date for †TP—Oct. 24, ‡CP Syn.—Nov. 8 CPMs—Nov. 16*)
Southern District Meeting
Hotel Heidelberg, Jackson, Miss.
April 3–5, 1957
(*Final date for †TP—Jan. 3, §DP Syn.—Jan. 20, DPMs—Jan. 30*)

*Final date for submitting paper—closed
†TP—Transactions paper
‡CP Syn.—Conference Synopsis
CPMs—Conference Manuscript
(The CPSyn. date is 10 days before the CPMs date)
§DP Syn.—District Synopsis
DPMs—District Manuscript
(The DPSyn. date is 10 days before the DPMs date)

Industrial Electronics Symposium Will Be Held September 24–25, 1956

The fifth annual Industrial Electronics Symposium will be held at the Hotel Manger, Cleveland, Ohio, September 24–25, 1956. Beside the AIEE, the Symposium will be sponsored by the Institute of Radio Engineers (IRE) and the IRE Professional Groups on Industrial Electronics and Production Techniques.

There will be four sessions in the technical program: electronic equipment design; automatic production; testing, gauging, and process control; and data reduction and analysis. Four papers per session are planned.

The IRE Professional Group on Industrial Electronics will present its annual award for the best paper presented. All registrants will receive a copy of the Symposium Transactions.

The Women's Auxiliary of the AIEE Cleveland Section has arranged an interesting program for the ladies.

Nonmembers as well as members of the sponsoring societies are welcome.

For additional information, contact C. F. Schunemann, Thompson Products, Inc., 2196 Clarkwood Road, Cleveland 3, Ohio.

The tentative technical program is as follows:

Monday, September 24

8:00 a.m. Registration

9:30 a.m. Session I. Electronic Equipment Design

Chairman: J. W. Picking, Reliance Electric and Engineering Company

Short Cuts in Printed Circuit Wiring. *Robert Ost*, Sperry Gyroscope Company

Human Engineering—An Aid to Improving Electronic Equipment. *Maurice Rappaport*, Stanford Research Institute

A Modern Concept of Electronic Packaging. *R. P. Noble*, Sandia Corporation

Packaging of Transistorized Assemblies. *A. A. Lawson*, *R. J. Simms*, Melpar Inc.

12:30 p.m. Luncheon

Speaker: Gen. B. W. Chidlaw, vice-president, Thompson Products, "Electronics in Air Defense and Air Offense"

2:00 p.m. Session II. Automatic Production

Chairman: R. W. Bols, *Automation* magazine

Automation for Electronics. *A. R. Gray*, Glenn L. Martin Company

Manufacture of Wire-Spring Relays for Commercial Switching Systems. *J. W. Rice*, Western Electric Company Inc.

Status of Standardization in Electronics Production and Machine Tool Controls. *E. H. Bosman*, International Business Machines

Production Testing in the Automatic Factory. *H. S. Dordick*, Radio Corporation of America

Tuesday, September 25

9:30 a.m. Session III. Testing, Gauging, and Process Control

Chairman: H. R. Weed, Ohio State University

The Industrial Electronics Concept. *Eugene Mittelmann*, consulting engineer

Variable-Speed Electronic Drives for Process Control. *A. J. Humphrey*, Reliance Electric and Engineering Company

Automatic Process Control with Radiation Gauges. *W. H. Faulkner, Jr.*, *G. F. Ziffer*, Tracerlab, Inc.

Measurement and Control in a Large Steam-Turbine Generator Department. *R. G. Goldman*, General Electric Company

12:30 p.m. Luncheon

Institute of Radio Engineers-Professional Group on Industrial Electronics Award Presentation

2:00 p.m. Session IV. Data Reduction and Analysis

Chairman: F. D. Brammer, Case Institute of Technology

Analog-Computer Study of an Electrical Constant Cutting-Speed Machine Tool Control Drive System. *W. J. Bradburn*, Louis Allis Company

Analog versus Digital Technique for Engineering Design Problems. *D. B. Breedon*, Westinghouse Electric Corporation

Computers—The Key to Modern Manufacturing Scheduling. *J. J. Gravel*, *T. F. Kavanagh*, General Electric Company

A Tank Farm Data Reduction System. *D. J. Gimpel*, Panellit Inc.

New Spokane Section Chairman

AMERICAN
INSTITUTE
OF
ELECTRICAL
ENGINEERS
SPOKANE
SECTION

DISTRICT 9 VICE-PRESIDENT J. R. Walker (*right*) looks on approvingly as retiring Spokane Section Chairman N. H. Meyers (*left*) presents the gavel to J. D. Fox (*center*) chairman for the coming year. The presentation was made at the conclusion of the Section's annual meeting at which Mr. Walker was a principal speaker.

Lamme Medal Nominations Must Be Submitted by December 1

Members of the Institute again are reminded that they have an opportunity to submit nominations for the 1956 Lamme Medal. All nominations must be received not later than December 1, 1956.

Details regarding qualifications for the award were published in the June 1956 issue of *Electrical Engineering*, page 573.

1956 Winner of Marston Medal Announced

J. O. Jackson, whose outstanding record in engineering research led him to the vice-presidency and a directorship in the Pittsburgh-Des Moines Steel Company, was announced recently as the 1956 winner of the Marston Medal at Iowa State College. The medal is awarded annually from a fund established by the late Dean Anson Marston of the Division of Engineering to recognize an outstanding engineering alumnus of the college each year. Award is made at Commencement exercises of the college.

Born in Denver, Colo., Mr. Jackson is a 1917 graduate of Iowa State College in civil engineering. He has been employed by the Pittsburgh-Des Moines Steel Company since his graduation. For the past 30 years, he has been in charge of all engineering activities of the company.

Mr. Jackson is a holder of over 30 United States patents covering elevated tanks, wind tunnels, and other steel structures. He has to his credit a number of inventions: the toroidal bottom elevated tank, the Icosasphere, double-shell insulated tanks, heat accumulators and exchangers, large size pressure regulator valves, and flexible nozzles for supersonic wind tunnels.

He is a member of the American Society of Civil Engineers, the American Welding Society, the American Society for Testing Materials, the American Petroleum Institute, the American Institute of Steel Construction, and the American Water Works Association.

The Marston Award is made each year by a board consisting of four alumni, one honorary member each of the AIEE, American

(*Continued on page 862*)

AIEE Officers and Committees for 1956-1957

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M. S. COOVER
Ames, Iowa
(*Term expires July 31, 1957*)

PAST PRESIDENTS

A. C. MONTEITH, Pittsburgh, Pa.
(*Term expires July 31, 1957*)

M. D. HOOVEN, Newark, N. J.
(*Term expires July 31, 1958*)

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8 BRADLEY COZZENS, Los Angeles, Calif.
10 B. G. BALLARD, Ottawa, Ont.
(*Terms expire July 31, 1957*)

District
1 D. E. GARR, Schenectady, N. Y.
3 L. F. STONE, Newark, N. J.
5 J. H. FOOTE, Jackson, Mich.
7 N. F. RODE, College Station, Tex.
9 M. M. EWELL, Portland, Ore.
11 H. H. KERR, Toledo, Ohio
(*Terms expire July 31, 1958*)

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(*Terms expire July 31, 1957*)

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(*Terms expire July 31, 1958*)

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(*Terms expire July 31, 1959*)

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(*Terms expire July 31, 1960*)

TREASURER

WALTER J. BARRETT, Newark, N. J.
(*Term expires July 31, 1957*)

SECRETARY

N. S. HIBSHMAN, New York, N. Y.
(*Term expires July 31, 1957*)

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956

DEPARTMENTS

Administration

J. C. Strasbourger, *Chairman*
Committees:
- Public Relations
- Sections

Admission and Advancement

J. L. Callahan, *Chairman*
Committees:
- Board of Examiners
- Membership
- Transfers

Publications

W. Scott Hill, *Chairman*

Professional Development and Recognition

W. A. Lewis, *Chairman*

Committees:
- Edison Medal
- Education
- Fortescue Fellowship
- Lamme Medal
- Management
- Members-for-Life
- Prize Awards
- Professional Conduct
- Registration of Engineers
- Student Branches

Technical Operations

W. R. Clark, *Chairman*
Committees:
- Research
- Safety
- Standards
- Six Divisions
- Technical Committees

LOCAL HONORARY SECRETARIES

AUSTRALIA—V. J. F. Brain, Electricity Authority of N.S.W., Box 2600 G.P.O. Sidney, New South Wales

BRAZIL—W. L. Simpson, Sao Paulo Light and Power Company, Caixa Postal 8026, Sao Paulo

ENGLAND—Sir A. P. M. Fleming, Metropolitan Vickers Electric Company, Trafford Park, Manchester 17

INDIA, NORTHERN—S. S. Kumar, Central Water and Power Commission, Bikaner House, New Delhi

INDIA, SOUTHERN—C. S. Ghosh, 20-B Hazra Road, Kalighat, Calcutta 26

IRELAND—Gerard M. Mulhern, Electricity Supply Board, 26 Lower Fitzwilliam St., Dublin

JAPAN—Hisagoro Mori, 32 Kawanishi Cho, Ashiya City

NEW ZEALAND—T. R. Pollard, Canterbury University College, Box 1152, Christchurch (acting)

PAKISTAN—Mohamed Hussain Khalid, Executive Engineer, Electricity, D. I. Khan, NWF

SWEDEN—Edy Velander, Box 5073, Stockholm 5

TRANSVAAL—Francis E. Ingham, Post Box 8605, Johannesburg, South Africa

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B. G. Ballard	Ottawa, Ont.
W. R. Brownlee	Birmingham, Ala.
D. I. Cone	Palo Alto, Calif.
L. F. Hickernell	Hastings-on-Hudson, N. Y.
M. D. Hooven	Newark, N. J.

Board of Examiners

R. A. Heising, *Chairman;* 232 Oak Ridge Ave., Summit, N. J.

L. F. Hickernell, *Vice-Chairman;* Hastings-on-Hudson, N. Y.

J. T. O'Halloran, *Secretary*	AIEE Headquarters
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R. H. Barclay	New York, N. Y.
H. H. Beverage	New York, N. Y.
H. W. Bibber	Schenectady, N. Y.
Hendley Blackmon	East Pittsburgh, Pa.
J. G. Brainerd	Philadelphia, Pa.
F. B. Bramhall	New York, N. Y.
R. F. Brower	New York, N. Y.
G. S. Brown	Cambridge, Mass.
W. R. Bullard	New York, N. Y.
C. A. P. Butcher	Westfield, N. J.
G. Calabrese	St. Albans, L. I., N. Y.
P. H. Chase	Philadelphia, Pa.
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J. W. Horton	New London, Conn.
C. T. Hughes	Waterbury, Conn.
R. A. Jones	New York, N. Y.
A. E. Knowlton	Short Beach, Conn.
G. H. Landis	Poughkeepsie, N. Y.
H. Logan	New York, N. Y.
H. H. Lowry	East Orange, N. J.
J. B. MacLean	New York, N. Y.
E. C. Molina	East Orange, N. J.
H. P. St. Clair	New York, N. Y.
R. T. Sawyer	Ho-Ho-Kus, N. J.
E. V. Sayles	Jackson, Mich.
H. W. Tenney	Jersey City, N. J.
Gordon Thompson	New York, N. Y.
H. M. Trueblood	Dobbs Ferry, N. Y.
B. Van Ness, Jr.	Allentown, Pa.
R. G. Warner	New Haven, Conn.
S. S. Watkins	New York, N. Y.
Ernst Weber	Brooklyn, N. Y.
E. P. Yerkes	Philadelphia, Pa.

Constitution and Bylaws

E. S. Lammers, Jr., *Chairman;* Westinghouse Electric Corporation, 1299 Northside Drive, N.W., Atlanta, Ga.

C. Dusenbury, *Secretary*	Atlanta, Ga.
W. L. Cassell	Ames, Iowa
D. D. Ewing	Lafayette, Ind.
J. H. Karr	Springfield, Ohio
W. W. Lewis	Schenectady, N. Y.
W. S. Peterson	Los Angeles, Calif.
P. G. Wallace	Dallas, Tex.

Edison Medal

Appointed by the President for term of five years

O. B. Blackwell	Plandome, N. Y.
J. F. Fairman	New York, N. Y.
E. P. Yerkes, *Chairman*	Philadelphia, Pa.
	(*Terms expire July 31, 1957*)
S. S. Attwood	Ann Arbor, Mich.
Charles F. Wagner	East Pittsburgh, Pa.
P. G. Wallace	Dallas, Tex.
	(*Terms expire July 31, 1958*)
R. Cutts, Jr., *Secretary*	Schenectady, N. Y.
J. D. Harper	Pittsburgh, Pa.
Elgin B. Robertson	Dallas, Tex.
	(*Terms expire July 31, 1959*)
A. C. Monteith	Pittsburgh, Pa.
J. D. Ryder	East Lansing, Mich.
F. O. Schnure	Wallpack Center, N. J.
	(*Terms expire July 31, 1960*)
W. L. Cisler	Detroit, Mich.
C. M. Mapes	New York, N. Y.
R. J. Wiseman	Passaic, N. J.
	(*Terms expire July 31, 1961*)

Members of the Board of Directors elected by the Board for term of two years

Bradley Cozzens	Los Angeles, Calif.
J. H. Foote	Jackson, Mich.
T. M. Linville	Schenectady, N. Y.
	(*Terms expire July 31, 1957*)
W. R. Brownlee	Birmingham, Ala.
M. D. Hooven	Newark, N. J.
L. M. Robertson	Denver, Colo.
	(*Terms expire July 31, 1958*)

Education

E. A. Walker, *Chairman;* Pennsylvania State University, University Park, Pa.

E. M. Williams, *Vice-Chairman*	Pittsburgh, Pa.
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F. C. Lindvall	Pasadena, Calif.
T. C. Lloyd	Springfield, Ohio
G. D. Lobingier	East Pittsburgh, Pa.
J. A. M. Lyon	Evanston, Ill.
D. W. McLenegan	Richland, Wash.
G. E. Moore	East Pittsburgh, Pa.
H. A. Peterson	Madison, Wis.
G. A. Richardson	Ames, Iowa
J. W. Rittenhouse	Cleveland, Ohio
J. D. Ryder	East Lansing, Mich.
W. J. Seeley	Durham, N. C.
H. H. Skilling	Stanford, Calif.
E. F. Smith	Gainesville, Fla.
L. N. Stone	Corvallis, Ore.
E. M. Strong	Ithaca, N. Y.
B. R. Teare, Jr.	Pittsburgh, Pa.
G. S. Timoshenko	Storrs, Conn.
G. F. Tracy	Toronto, Ont., Canada
S. Reid Warren, Jr.	Philadelphia, Pa.
Ernst Weber	Brooklyn, N. Y.

Finance

T. M. Linville, *Chairman;* General Electric Company, P. O. Box 1088, Schenectady, N. Y.

L. F. Stone	Newark, N. J.
J. D. Tebo	New York, N. Y.

Fortescue Fellowship

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. 75
56

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. 75
956

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9	North West	M. M. Ewell, Westinghouse Electric Corporation, 309 S.W. 6th Ave., Portland 4, Ore.	H. Arnett, Portland General Electric Company, 621 S.W. Alder St., Portland 5, Ore.	R. E. Durnford, Dept. of Electrical Engineering, Montana State College, Bozeman, Mont.
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Alabama	4	May 22, '29	Leon B. Murray	D. E. Straley	General Electric Company, 600 No. 18th St., Birmingham 2, Ala.
Arizona	8	Mar. 22, '41	T. A. Phillips	L. A. Potter	1818 W. Rovey Ave., Phoenix, Ariz.
Arkansas	7	Apr. 23, '47	R. H. Boyd	Marion M. Riggs	80 Cypress Dr., Pine Bluff, Ark.

Arrowhead	5	Apr. 23, '47	L. N. Day	P. L. Bush	Jones and Laughlin Steel Corporation, Minnesota Ore Div., Box 941, Virginia, Minn.
Baton Rouge	4	Feb. 3, '55	S. L. Adams	R. B. Hollaway	6632 Seven Oaks Ave., Baton Rouge, La.
Beaumont	7	June 27, '45	Ray Welborn, Jr.	Lloyd B. Cherry	Dept. of Electrical Engineering, Lamar State College of Technology, Beaumont, Tex.
Boston	1	Feb. 13, '03	L. T. Jester	H. W. Evirs, Jr.	Fitchburg Gas and Electric Light Company, 89 Broad St., Boston 10, Mass.
Canton	11	Nov. 4, '47	R. T. Trier	D. J. Harper	184 Wipple Rd., N.W., Canton, Ohio
Central Illinois	5	June 28, '51	Wendell J. Kelley	G. P. Wilson	1032 No. Third St., Springfield, Ill.
Central Indiana	5	Jan. 12, '12	T. W. Metz	J. R. Wark	Indianapolis Power and Light, Indianapolis, Ind.
Chicago	5	1893	E. R. Whitehead	E. G. Norell	Sargent and Lundy, 140 So. Dearborn St., Chicago 3, Ill.
Cincinnati	11	June 30, '20	D. T. Michael	F. M. Foster	Planet Products, 6305 Warwick Ave., Cincinnati 27, Ohio
Cleveland	11	Sept. 27, '07	R. C. Berger	E. C. Barnes	Reliance Electrical and Engineering Company, 1088 Ivanhoe Rd., Cleveland 10, Ohio
Columbus	11	Mar. 17, '22	C. H. Varnfield	P. L. Gilmore, Jr.	1041 Summit St., Columbus 1, Ohio
Connecticut	1	Apr. 16, '21	W. A. Upham	F. W. Engster	General Electric Company, 129 Church St., New Haven, Conn.
Corpus Christi	7	Oct. 25, '51	M. H. Lovelady	Richard Godeke	Allis Chalmers Manufacturing Company, 417 Medical Professional Bldg., Corpus Christi, Tex.
Dayton	11	June 9, '43	Robert J. O'Brien	B. J. Pleiss, Jr.	Box 273, Bellbrook, Ohio
Delaware Bay	2	June 1, '52	F. A. Anderson	C. S. Collier	2 Corrine Ct., Wilmington 3, Del.
Denver	6	May 18, '15	Max H. Kight	H. P. Deming	Stearns-Roger Manufacturing Company, 660 Bannock St., Denver, Col.
East Tennessee	4	Sept. 2, '30	Hugh C. Sells	Jack Witherspoon	Robertshaw-Fulton Controls Company, Fulton Sylphon Div., Knoxville, Tenn.
El Paso	7	Mar. 7, '40	Norman Peyton	Richard Combs	Westinghouse Electric Corporation, P. O. Box 1825, El Paso, Tex.
Erie	2	Jan. 11, '18	J. C. Van Arsdell	J. J. Grumblatt	3424 Melrose Ave., Erie, Pa.
Fort Wayne	5	Aug. 14, '08	J. H. Capps	B. C. Biega	2317 Lynn Ave., Fort Wayne, Ind.
Georgia	4	Jan. 14, '04	T. J. Allen	W. J. McKune	Georgia Institute of Technology, Dept. of Electrical Engineering, Atlanta, Ga.
Hamilton	10	May 1, '53	H. W. Blackett	A. Gordon Carter	471 E. 37th St., Mohawk P. O., Hamilton, Ont., Canada
Hawaii	8	June 24, '54	J. A. Rolfing, Jr.	F. B. Martin, Jr.	Box 1235, Waipahu, Oahu, T. H.
Houston	7	Aug. 7, '28	Charles S. Williams	V. P. Parr	Southwestern Bell Telephone Company, 601 Lockwood Dr., Houston 11 Tex.
Illinois Valley	5	June 30, '45	T. J. Ptasnik	R. M. Ryan	General Electric Company, Jefferson Bldg., Peoria, Ill.
Iowa	5	June 29, '29	R. F. Schlenker	O. A. Tennant	Westinghouse Electric Corporation, 1408 Walnut, Des Moines Iowa
Iowa-Illinois	5	June 24, '54	F. D. Newberry	C. W. Lauritzen	830 43rd St., Rock Island, Ill.
Ithaca	1	Oct. 15, '02	J. L. Rosson	I. W. Keller	187 Bower Road, Elmira, N. Y.
Jacksonville	4	Jan. 28, '31	John T. Graham	Leroy E. Elliott	P. O. Box 48, Station G, Jacksonville, Fla.
Johnstown	2	Apr. 14, '55	A. E. Molinski	R. D. Good	Pennsylvania Electric Company, 222 Levergood St., Johnstown, Pa.
Kansas City	7	Apr. 14, '16	E. L. Sitz	H. R. Vaughan	Westinghouse Electric Corporation, 101 W. 11th St., Kansas City 6, Mo.
Lehigh Valley	2	Apr. 16, '21	F. S. Fehr	L. L. Nonemaker	Pennsylvania Power and Light Company, 901 Hamilton St., Allentown, Pa.
Lima	11	June 24, '54	W. T. Gordon	N. E. Eberhart	324 So. Nye St., Lima, Ohio
Los Angeles	8	May 19, '08	P. L. Savage	E. Dale Barcus	Pacific Telephone and Telegraph Company, 740 South Olive St., Room 816, Los Angeles 55, Calif.
Louisville	4	Oct. 15, '26	W. J. Ryan	W. B. Watkins, Jr.	Premier Thermoplastics Company, Jeffersontown, Ky.
Lynn	1	Aug. 22, '11	F. O. MacFee, Jr.	F. M. W. Strojny	Sylvania Electric Corporation, Inc., 64 Sylvan St., Danvers, Mass.
Madison	5	Jan. 8, '09	Russell J. LeBosquet	John T. Wright	Carl C. Crane, Inc., 2702 Monroe St., Madison 5, Wis.
Maine	1	June 30, '55	H. A. Crosby	Basil Payne	Central Maine Power Company, 9 Green St., Augusta, Maine
Mansfield	11	Mar. 6, '39	B. F. Parr	J. G. Idle	Westinghouse Electric Corporation, Mansfield, Ohio
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Memphis	4	May 22, '30	G. C. Davis	R. D. Barrett	Memphis Light, Gas and Water Company, Memphis, Tenn.
Mexico	7	June 29, '22	G. S. Payan	A. W. Gelbke	Apartado 8 Bis., Mexico, D. F., Mexico
Miami	4	Feb. 3, '49	E. M. Keller	E. C. Cornelius	Cornelius Electric Company, 3600 N.W. 48th St., Miami, Fla.
Michigan	5	Jan. 13, '11	F. Von Voightlander	H. M. Hess	Wayne University, 4841 Cass Ave., Detroit 1, Mich.
Milwaukee	5	Feb. 11, '10	N. C. Storck	E. A. Dickinson	1012 E. Sylvan Ave., Milwaukee 11, Wis.
Minnesota	5	Apr. 7, '02	R. G. Lynn	J. H. Forchtner	Northwestern Bell Telephone Company, 224 So. Fifth St., Minneapolis 2, Minn.
Mississippi	4	June 28, '51	N. L. Stampley	J. R. Burnie	Southern Bell Telephone and Telegraph Company, P. O. Box 811, Jackson, Miss.
Mobile-Pensacola	4	Jan. 22, '53	R. A. Porter	E. E. Cobb	Gulf Power Company, 8–10 No. Palafox St., Pensacola, Fla.
Montana	9	June 24, '31	W. S. Wheeler	H. L. Baker	General Delivery, Billings, Montana
Montreal	10	Apr. 16, '43	A. C. Abbott		
Nashville	4	June 28, '51	R. D. Bourne	H. C. Hartman, Jr.	2214 Crestmoor Rd., Nashville 12, Tenn.
Nebraska	6	Jan. 21, '25	E. J. Ballard, Jr.	M. I. Risley	Northwestern Bell Telephone Company, 118 So. 19th St., Omaha 2, Neb.
New Hampshire	1	Sept. 3, '53	F. H. Busch	Richard A. Nichols	Public Service Company of New Hampshire, 1087 Elm St., Manchester, N. H.
New Orleans	4	Dec. 8, '33	Daniel Vliet	Stanley G. Dinkel	General Electric Company, 1004 Richards Bldg., New Orleans, 12, La.
New York	3	Dec. 10, '19	W. A. Clark	W. T. Rea	Bell Telephone Labs., Inc., 463 West St., New York, N. Y.
Niagara Frontier	1	Feb. 10, '25	D. J. Munhall	Milo L. Rowley	New York Telephone Company, 63 E. Delavan Ave., Buffalo 8, N. Y.
Niagara International	10	Aug. 5, '48	K. McCaskill	J. D. Jambro	2943 Cleveland Ave., Niagara Falls, N. Y.
North Carolina	4	Mar. 21, '29	J. C. Bregar	Quentin T. Brown	Western Electric Company, Radio Div., Winston-Salem, N. C.
Northeastern Michigan	5	Feb. 2, '50	F. W. Inman	W. A. Stelzer	4310 No. Jefferson, Midland, Mich.
Northern New Mexico	7	Jan. 25, '51	Neith J. Pollard.	T. F. Douglas	Public Service Company, P. O. Box 1360, Albuquerque, N. M.
North Texas	7	May 18, '28	F. W. Tatum	D. N. Chadwick	Dallas Power and Light Company, 1506 Commerce St., Dallas 1, Tex.
Oak Ridge	4	Feb. 1950	D. B. Janney	A. S. Willumsen	327 E. Drive, Oak Ridge, Tenn.
Ohio Valley	11	June 28, '51	W. R. Wagner	R. D. Crippen	3120 3rd Ave., Huntington, W. Va.
Oklahoma City	7	Feb. 16, '22	Gerald Tuma	G. E. Brooks	Oklahoma Gas and Electric Company, P. O. Box 1498, Oklahoma City, Okla.
Ottawa	10	June 25, '49	L. N. Moore	E. W. Humphrys	North West Territories Power Commission, 150 Wellington St., Ottawa, Ont., Canada
Panhandle Plains	7	June 12, '47	T. C. Young	J. R. Ragland	H. N. Roberts and Associates, P. O. Box 3008, Lubbock, Tex.
Philadelphia	2	Feb. 18, '03	M. J. A. Dugan	G. B. Schleicher	Philadelphia Electric Company, 2301 Market St., Philadelphia, Pa.
Pittsburgh	2	Oct. 3, '02	W. H. Osterle	W. R. Harris	Westinghouse Electric Corporation, E. Pittsburgh, Pa.
Pittsfield	1	Mar. 25, '04	W. A. McMorris	J. A. Van Lund, Jr.	Box 544, Lenox, Mass.
Portland	9	May 18, '09	A. E. Opdenweyer	L. H. Wolgast	Reynolds Metals Company, Troutdale, Ore.
Providence	1	Mar. 12, '20	E. E. Linden	V. F. Hill	20 Lynden Rd., Cranston 5, R. I.
Richland	9	Apr. 23, '48	R. C. Hoffman	I. M. A. Garcia	P. O. Box 836, Richland, Wash.
Ridgway	2	June 26, '52	W. E. Yohe	J. S. Askey	Elliott Company, Ridgway, Pa.
Rochester	1	Oct. 9, '14	L. C. Holmes	J. T. Johnson	Westinghouse Electric Company, 1 McKee, P. O. Box 1788, Rochester, N. Y.
Rock River Valley	5	Apr. 23, '47	T. C. Cameron	R. E. Ford	Cutler-Hammer, Inc., 1404 No. Main St., Rockford, Ill.
Sacramento	8	June 15, '50	P. E. Shaad	R. N. Keen	General Electric Company, 626 Forum Bldg., Sacramento 14, Calif.
St. Louis	7	Jan. 14, '03	R. C. Hase	F. R. Summers	Westinghouse Electric Company, 411 No. Seventh St., St. Louis 1, Mo.
St. Maurice Valley	10	June 24, '54	E. A. Gareau	J. J. Daoust	Consolidated Paper Corporation, Shawinigan Falls, Que., Canada
San Diego	8	Jan. 18, '39	C. R. Lufkin	L. L. LaZelle	3427 Quince St., San Diego 4, Calif.
San Francisco	8	Dec. 23, '04	W. G. Collins	M. G. Lewis	Bechtel Corporation, 101 California St., San Francisco, Calif.
Savannah	4	Oct. 14, '54	J. E. Odom	F. B. Hickman	Westinghouse Electric Supply Company, P. O. Box 589, Savannah, Ga.
Schenectady	1	Jan. 26, '03	D. S. Brereton	J. C. White	34 St. Stephen's Lane, Scotia 2, N. Y.
Seattle	9	Jan. 19,' 04	C. R. Kingsbury	E. M. Lee	General Electric Company, P. O. Box 1858, Seattle, Wash.
Sharon	2	Dec. 11, '25	H. L. Prescott		
Shreveport	7	June 12, '47	R. G. Flowers	J. G. Boyd	Southwestern Gas and Electric Company, P. O. Box 1106, Shreveport 83, La.
South Bend	5	Feb. 26, '41	J. P. Jordan	F. W. Baumgartner	F. H. Langsenkamp Company, South Bend, Ind.
South Carolina	4	Mar. 2, '40	C. A. Smith	H. S. Sanders	109 So. Boundary, Aiken, S. C.
South Texas	7	May 23, '30	R. M. Jolly	F. O. December	222 Beatrice Ave., San Antonio 4, Tex.

Spokane	9	Feb. 14, '13	J. D. Fox	L. C. Ford	General Electric Company, So. 162 Post, Spokane 4, Wash.
Springfield	1	June 29, '22	M. G. Moses	C. G. Schmidt	14 Harrison Ave., Holyoke, Mass.
Susquehanna	2	June 18, '53	W. A. Lentz	D. B. Chubb	Trinidad Apts. 3, Hershey, Pa.
Syracuse	1	Aug. 12, '20	Paul Kartluke	W. A. Bangs	615 W. Brighton Ave., Syracuse, N. Y.
Tampa	4	Feb. 1, '52	G. L. Kenny, Jr.	R. N. Garrison	Tampa Armature Works, P. O. Box 1318, Tampa, Fla.
Toledo	11	June 3, '07	J. F. Craig	W. H. Schwalbert	3824 Maxwell Rd., Toledo 13, Ohio
Toronto	10	Sept. 30, '03	J. T. Fisher	E. A. Ricker	Ontario Hydro, Engineering Building, 620 University Ave., Toronto 2, Ont., Canada
Tulsa	7	Oct. 1, '37	W. B. Nesbitt	D. M. Allison	Westinghouse Electric Corporation, 703 Enterprise Bldg., Tulsa 3, Okla.
Utah	9	Mar. 9, '17	J. A. Davis	E. W. Hendron	Dept. of Electrical Engineering, University of Utah, Salt Lake City 1, Utah
Vancouver	9	Aug. 22, '11	R. B. Carter	M. I. G. Bradwell	B. C. Engineering Company, Ltd., 960 Richards St., Vancouver 2, B. C., Canada
Virginia	4	May 19, '22	W. P. Molette	D. J. Ball	Newport News Shipbuilding and Dry Dock Company, Plant Engineers Office, Newport News, Va.
Virginia Mountain	4	June 23, '49	J. B. Whitmore	G. R. Meek	1615 Windsor Ave., S. W., Roanoke, Va.
Washington	2	Apr. 9, '03	D. S. Bender	Robert E. Morris	Allis-Chalmers Manufacturing Company, 717 Wyatt Bldg., Washington 5, D. C.
West Michigan	5	June 24, '54	James Frye	William S. Wright	1460 Burke, N. E., Apt. D, Grand Rapids, Mich.
West Virginia	11	Apr. 9, '40	J. H. Miller	E. C. Krukiel	5007 Virginia Ave., S. E., Charleston, W. Va.
Wichita	7	Sept. 16, '37	W. P. Lyttle	W. R. Hollingsworth	Westinghouse Electric Corporation, 213 So. Main St., Wichita, Kan.
Worcester	1	Feb. 18, '20	G. W. Carlson	W. J. Creighton	General Electric Company, 288 Grove St., Worcester 5, Mass.
Total Sections	109				

Subsections

Name	Chairman	Secretary	Secretary's Address
Adirondack (Schenectady Section)	F. G. Stebbins	G. L. Viles	General Electric Company, Bldg. 1–4, Hudson Falls, N. Y.
Atlantic City Division (Philadelphia Section)	O. M. Olsen	J. P. Faunce	Atlantic City Electric Company, 1600 Pacific Ave., Atlantic City, N. J.
Billings (Montana Section)	C. R. Beitman	C. W. Lee	1017—25th St., W., Billings, Mont.
Binghamton Area (Ithaca Section)	L. N. Vacca	L. L. Brandow	New York State Electric and Gas Company, Box 1111, Binghamton, N. Y.
Black Hills (Denver Section)	Robert Ashiem	D. O. Flahart	60 St. Joe St., Rapid City, S. D.
Blue Ridge (Virginia Section)	H. W. Gayek	M. W. Jones	Thornton Hall, University of Virginia, Charlottesville, Va.
Boise (Utah Section)	P. W. Worthen	W. Bruce Mitchell	Route 2, Parma, Idaho
Boulder City (Los Angeles Section)	F. L. Long, Jr.	L. F. Hartman	511 Cherry St., Boulder City, Nev.
Cedar Valley (Iowa Section)	C. R. White	O. W. Amandor	Iowa Electric Light and Power Company, P. O. Box 351, Cedar Rapids, Iowa
Central Savannah River (South Carolina Section)	W. P. McDonald	C. K. Harschbarger	907 Holiday Dr., No. Augusta, S. C.
Central Texas (North Texas Section)	D. E. Dennis	R. J. Sayger	Brazos Electric Power Cooperative, Inc., 2404–12 LaSalle Ave., Waco, Tex.
Centre County (Pittsburgh Section)	R. M. Hoover	Richard Strand	Electrical Engineering Dept., Pennsylvania State University, University Park, Pa.
Charleston (South Carolina Section)	D. N. Johanson	R. L. Johnson	South Carolina Electric and Gas Company, 141 Meeting St., Charleston, S. C.
Charlotte (North Carolina Section)	L. C. Moore	C. M. Gadsden	Duke Power Company, Charlotte, N. C.
Chillicothe (Columbus Section)	H. M. Kallaher	F. S. Kalisik	414 Gordon Ave., Waverly, Ohio
Columbia (South Carolina Section)	J. F. Castles	T. O. McKeown, Jr.	Southern Bell Telephone and Telegraph Company, Box 752, Columbia, S. C.
Eastern Division (St. Louis Section)	J. G. Lawrence	J. H. Lamming	1141 No. Drive, Warson Woods, St. Louis County, Mo.
Eastern Idaho (Utah Section)	M. M. Dye	R. E. Rubel	1101 Ada Avenue, Idaho Falls, Idaho
Eastern North Carolina (North Carolina Section)	P. S. Colby	E. J. Moore	Wright Machinery Company, Durham, N. C.
Eastern Shore (Maryland Section)	R. P. Graham	E. L. Bradford	Mt. Hermon Rd., Route 4, Salisbury, Md.
Eugene (Portland Section)	P. C. Magnusson	D. M. Hoffman	62 W. 13th Ave., Eugene, Ore.
Fort Worth (North Texas Section)	J. C. Bibbs	J. D. Padgett	3229 Richardson, Fort Worth, Tex.
Fox River Valley (Milwaukee Section)			
Freeport (Houston Section)			
Fresno Division (San Francisco Section)	J. O. Girven	C. L. Smith	525 Poplar Ave., Fresno 4, Calif.
Great Falls (Montana Section)			
Hampton Roads (Virginia Section)	Mrs. Kitty O'B Joyner	R. B. Helfrisch	Bird Neck Pt., Virginia Beach, Va.
Helena (Montana Section)	M. O. Goldberg	Howard C. Olsen	Mountain States Tel. and Tel. Company, 441 N. Park, Helena, Mont.
Hudson Valley Division (New York Section)	J. R. Vogel	J. E. Ruscher	49 Carroll St., Poughkeepsie, N. Y.
Huntsville (East Tennessee Section)	M. A. Kalange	C. O. Brooks	109 Concord Rd., Huntsville, Ala.
Lake Charles (Beaumont Section)	J. R. Boozer	P. A. Harrington	3800 Kingston St., Lake Charles, La.
Lexington (Louisville Section)	Vaughn Drake	I. B. Irvine	409 Queensway, Lexington, Ky.
London (Hamilton Section)	T. H. Lewis	R. T. Houlihan	Canadian Westinghouse Co., Huron and Erie Building, London, Ont., Canada
Los Alamos-Santa Fe (Northern New Mexico Section)	Daniel Pfaff	L. E. Lanham	1929—41st. St., Los Alamos, N. M.
Marion (Fort Wayne Section)			
Medford (Portland Section)	E. B. Hedberg	C. R. Rolls	1024 Mt. Pitt Ave., Medford, Ore.
Merrimack Valley (Lynn Section)	R. W. Allen, Sr.	P. Chontoian	Western Electric Company, South Union St., Lawrence, Mass.
Mid-State (North Carolina Section)	S. N. Kirkman	C. A. Rhodes, Jr.	1139 Martin St., Winston-Salem, N. C.
Monroe (Shreveport Section)	R. N. Kettenring	R. B. Bailey	Louisiana Power and Light Company, 101 Cotton St., West Monroe, La.
Monterey (Mexico Section)			
Montgomery (Alabama Section)	E. L. Robinson	E. V. Harding	Mathews, Ala.
Muscle Shoals (East Tennessee Section)	Richard Darcy	R. L. Townsend	1009 N. Wood Ave., Florence, Ala.
New Jersey Division (New York Section)	H. F. Herbig	H. W. Lensner	95 Orange St., Dept. C-3, Newark, N. J.
Northwest Arkansas (Arkansas Section)	A. S. Brown	H. B. Carruth	South West Gas and Electric Company, DeQueen, Ark.
Northwest Iowa (Iowa Section)	M. B. Hurd	C. N. Marple	Iowa Public Service Company, 515—5th St., Sioux City, Iowa
Paducah (Louisville Section)	W. J. Brockenborough	F. J. VonHollen	1149 Elmdale, Apt. A, Paducah, Ky.
Piedmont (South Carolina Section)	H. V. Poe	L. P. Thompson, Jr.	Engineering Department, Southern Bell Telephone and Telegraph Company, Greenville, S. C.
Quebec (Montreal Section)	E. J. Bobyn	G. Galibois	Quebec Power Company, 399 St. Joseph St. E., Quebec, P. Q., Canada
Racine-Kenosha (Milwaukee Section)	B. M. Batenburg	A. Welch	George Gorton Machine Company, Racine, Wis.
Red River Valley Division (Minnesota Section)	Edwin Anderson	C. J. Thomforde	University Station, Grand Forks, N. D.
Reno (San Francisco Section)	M. S. Murphy	W. J. Wright	Sierra Power Company, 220 So. Virginia St., Reno, Nev.
Richmond (Virginia Section)	M. S. Spicer	C. W. Parker, Jr.	Allis-Chalmers Manufacturing Company, 608 Electric Bldg., Richmond 19, Va.
Riverside-San Bernardino (Los Angeles Section)	K. V. Fletcher	C. L. Westmann	Southern California Edison Company, P. O. Box 69, San Bernardino, Calif.
St. Lawrence International (Syracuse Section)	J. G. McAllister	W. J. Mitchell	15-A Second St. E., Cornwall, Ont., Canada
San Jose Division (San Francisco Section)	W. Wedekind	D. R. Nelson	General Electric Company, 2155 So. First St., San Jose, Calif.
Scioto Valley (Ohio Valley Section)	J. K. Boughton	Victor Ritter	2519 Ritchie St., Portsmouth, Ohio
Shasta Division (San Francisco Section)	A. L. McLean	O. J. Horst	Route 3, Box 452, Chico, Calif.
Southern Colorado (Denver Section)			
Tacoma (Seattle Section)	C. H. Staff	C. K. Meek	811 E. 121st St., Tacoma 44, Wash.

Tullahoma (East Tennessee Section)	H. C. Daniels	C. L. Stumpf	General Delivery, Tullahoma, Tenn.
Vancouver Island (Vancouver Section)	A. F. Thommasen	E. T. Davis	2162 Neil St., Vancouver, B. C., Canada
Vermont (Pittsfield Section)	E. M. Palmer	R. O. King	Green Mountain Power Corporation, State St., Montpelier, Vt.
Wenatchee (Spokane Section)	E. C. Metcalf	R. J. Tallman	590 Colorado Ave., E. Wenatchee, Wash.
West Central Texas Division (North Texas Section)	Jack Covington	H. R. Oliver	1133 Jefferson St., Abilene, Tex.
Western North Carolina (North Carolina Section)	J. D. Sloan	W. T. Batts	American Enka Corp., Enka, N. C.
Zanesville (Columbus Section)	T. E. Raymond, Jr.	W. M. Pahel	Bloomfield Rd., New Concord, Ohio

Total Subsections..................65

Student Branches

Name and Location	District	Counselor (Member of Faculty)
*Akron, University of, Akron, Ohio	11	Kenneth F. Sibila
Alabama Polytechnic Institute, Auburn, Ala.	4	Albert T. Sprague, Jr.
Alabama, University of, University, Ala.	4	W. F. Gray
†Alaska, University of, College, Alaska	9	Robert P. Merritt
*Alberta, University of, Edmonton, Alta., Canada	10	R. E. Phillips
*Arizona, University of, Tucson, Ariz.	8	James L. Knickerbocker
*Arkansas, University of, Fayetteville, Ark.	7	Bryan Webb, Jr.
†Bradford Durfee Technical Institute, Fall River, Mass.	1	B. B. Hardy
*British Columbia, University of, Vancouver, B.C., Canada	9	L. R. Kersey
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Day)	3	F. A. Wahlers
*Brooklyn, Polytechnic Institute of, Brooklyn, N. Y. (Evening)	3	Frederick G. Van Note
*Brown University, Providence, R. I.	1	C. M. Angulo
*Bucknell University, Lewisburg, Pa.	2	George A. Irland
†Buffalo, University of, Buffalo, N. Y.	1	F. P. Fischer
*California Institute of Technology, Pasadena, Calif.	8	G. D. McCann
†California State Polytechnic College, San Luis Obispo, Calif.	8	Warren R. Anderson
*California, University of, Berkeley, Calif.	8	Henry C. Bourne, Jr.
*Carnegie Institute of Technology, Pittsburgh, Pa.	2	Richard E. Smith
Case Institute of Technology, Cleveland, Ohio	11	R. D. Chenoweth
Catholic University of America, Washington, D. C.	2	J. C. Michalowicz
*Cincinnati, University of, Cincinnati, Ohio	11	Carl F. Evert, Jr.
Clarkson College of Technology, Potsdam, N. Y.	1	Ralph Gentile
Clemson A & M College, Clemson, S. C.	4	H. V. Poe
*Colorado A & M College, Fort Collins, Colo.	6	P. H. Lindon
*Colorado, University of, Boulder, Colo.	6	George E. Gless, Jr.
*Columbia University, New York, N. Y.	3	P. Mauzey
*Connecticut, University of, Storrs, Conn.	1	Harold M. Lucal
*Cooper Union, New York, N. Y.	3	E. W. Starr
*Cornell University, Ithaca, N. Y.	1	Norman Vrana
*Dayton, University of, Dayton, Ohio	11	Louis H. Rose
*Delaware, University of, Newark, Del.	2	H. S. Bueche
*Denver, University of, Denver, Col.	6	Arlie E. Paige
*Detroit, University of, Detroit, Mich.	5	Robert W. Ahlquist
*Drexel Institute of Technology, Philadelphia, Pa.	2	F. C. Powell
Duke University, Durham, N. C.	4	Harry A. Owen, Jr.
Fenn College, Cleveland, Ohio	11	R. W. Schindler
*Florida, University of, Gainesville, Fla.	4	L. F. Schoonmaker
†Gannon College, Erie, Pa.	2	J. L. Mundy
*George Washington University, Washington, D. C.	2	D. J. Hanrahan
Georgia Institute of Technology, Atlanta, Ga.	4	E. R. Weston
†Houston, University of, Houston, Tex.	7	W. T. Kittinger
Howard University, Washington, D. C.	2	E. R. Welch
Idaho, University of, Moscow, Idaho	9	W. R. Parish
Illinois Institute of Technology, Chicago, Ill.	5	B. A. Fisher
*Illinois, University of, Urbana and Chicago Division, Chicago, Ill.	5	J. E. Williams
*Iowa State College, Ames, Iowa	5	G. A. Richardson
Iowa, University of, Iowa City, Iowa	5	E. B. Kurtz
*Johns Hopkins University, Baltimore, Md.	2	Thorsten Larsen
Kansas State College, Manhattan, Kans.	7	J. E. Ward, Jr.
*Kansas, University of, Lawrence, Kans.	7	Louis Breyfogle
Kentucky, University of, Lexington, Ky.	4	Gustavus E. Smith
*Lafayette College, Easton, Pa.	2	F. W. Smith
†Lamar State College of Technology, Beaumont, Tex.	7	Lloyd B. Cherry
Laval University, Quebec, Que., Canada	10	Maurice Boisvert
Lehigh University, Bethlehem, Pa.	2	Joseph Teno
Louisiana Polytechnic Institute, Ruston, La.	7	M. R. Johnson
*Louisiana State University, Baton Rouge, La.	4	M. B. Reed
*Louisville, University of, Louisville, Ky.	4	Miles G. Northrop
*Maine, University of, Orono, Maine	1	P. M. Seal
*Manhattan College, New York, N. Y.	3	Robert T. Weil, Jr.
*Marquette University, Milwaukee, Wis.	5	Stanley Krupnik
*Maryland, University of, College Park, Md.	2	L. J. Hodgins
*Massachusetts Institute of Technology, Cambridge, Mass.	1	John A. Tucker
*Massachusetts, University of, Amherst, Mass.	1	J. W. Mohn
†Miami, University of, Coral Gables, Fla.	4	Blas B. Mazzeo
*Michigan College of Mining and Technology, Houghton, Mich.	5	G. W. Swenson
*Michigan State University, East Lansing, Mich.	5	H. E. Hedges
*Michigan, University of, Ann Arbor, Mich.	5	J. G. Tarboux
Milwaukee School of Engineering, Milwaukee, Wis.	5	R. J. Ungrodt
*Minnesota, University of, Minneapolis, Minn.	5	Paul A. Cartwright
Mississippi State College, State College, Miss.	4	J. C. McKee, Jr.
*Missouri School of Mines and Metallurgy, Rolla, Mo.	7	Claude J. Grimm
*Missouri, University of, Columbia, Mo.	7	J. C. Hogan
*Montana State College, Bozeman, Mont.	9	R. F. Durnford
*Nebraska, University of, Lincoln, Neb.	6	A. R. Edison
*Nevada, University of, Reno, Nev.	8	William L. Garrott
Newark College of Engineering, Newark, N. J.	3	R. R. Meola
†New Bedford Institute of Textiles and Technology, New Bedford, Mass	1	Lenine Gonsalves
*New Hampshire, University of, Durham, N. H.	1	J. B. Murdoch
* New Mexico College of A & M Arts, State College, N. M.	7	C. D. Crosno
*New Mexico, University of, Albuquerque, N. M.	7	J. Lawton Ellis
*New York, College of the City of, New York, N. Y.	3	W. T. Hunt
*New York University, New York, N. Y. (Day)	3	L. J. Hollander
*New York University, New York, N. Y. (Evening)	3	L. J. Hollander
*North Carolina State College, Raleigh, N. C.	4	Edwin W. Winkler
*North Dakota State College, Fargo, N. D.	5	R. N. Faiman
*North Dakota, University of, Grand Forks, N. D.	5	John D. Dixon
*Northeastern University, Boston, Mass.	1	Richard I. Carter
*Northwestern University, Evanston, Ill.	5	D. B. Robinson
*Norwich University, Northfield, Vt.	1	Thomas M. Riley
*Notre Dame, University of, Notre Dame, Ind.	5	L. F. Stauder
Ohio Northern University, Ada, Ohio	11	Robert H. Nau
*Ohio State University, Columbus, Ohio	11	E. E. Kimberly
*Ohio University, Athens, Ohio	11	D. B. Green
*Oklahoma A & M College, Stillwater, Okla.	7	Frank E. McFarlin
*Oklahoma, University of, Norman, Okla.	7	Gerald Tuma
*Oregon State College, Corvallis, Ore.	9	L. N. Stone
*Pennsylvania State College, University Park, Pa.	2	R. E. Armington
*Pennsylvania, University of, Philadelphia, Pa.	2	Raymond Berkowitz
Pittsburgh, University of, Pittsburgh, Pa.	2	R. C. Gorham
*Pratt Institute, Brooklyn, N. Y.	3	Maurice Hashmall
*Princeton University, Princeton, N. J.	2	H. M. Chandler, Jr.
Puerto Rico, University of, Mayaguez, P. R.	3	Jose Luis G. DeQuevedo
*Purdue University, Lafayette, Ind.	5	Stephen Freeman, Jr.
*Rensselaer Polytechnic Institute, Troy, N. Y.	1	E. D. Broadwell
*Rhode Island, University of, Kingston, R. I.	1	R. S. Haas
*Rice Institute, Houston, Tex.	7	Paul E. Pfeifler
*Rose Polytechnic Institute, Terre Haute, Ind.	5	R. D. Strum
*Rutgers University, New Brunswick, N. J.	3	John P. Newton
*Saint Louis University, St. Louis, Mo.	7	William M. McCabe
Santa Clara, University of, Santa Clara, Calif.	8	Jack A. Peterson
†Seattle University, Seattle, Wash.	9	Francis P. Wood
*South Carolina, University of, Columbia, S. C.	4	J. Hubert Noland, Jr.
South Dakota School of Mines and Technology, Rapid City, S. D.	6	William A. Hixson
South Dakota State College, Brookings, S. D.	5	John N. Cheadle
*Southern California, University of, Los Angeles, Calif.	8	Rodney C. Lewis
*Southern Methodist University, Dallas, Tex.	7	F. W. Tatum
*Stanford University, Stanford, Calif.	8	W. G. Hoover
*Stevens Institute of Technology, Hoboken, N. J.	3	L. E. Backer
Swarthmore College, Swarthmore, Pa.	2	Carl Barus
*Syracuse University, Syracuse, N. Y.	1	W. R. Le Page
†Tennessee Polytechnic Institute, Cookeville, Tenn.	4	Albert L. Duke
Tennessee, University of, Knoxville, Tenn.	4	Charles Weaver
*Texas, A & M College of, College Station, Tex.	7	John Scott Denison
†Texas College of Arts and Industries, Kingsville, Tex.	7	Emerson Korges
*Texas Technological College, Lubbock, Tex.	7	T. B. Stenis
* Texas, University of, Austin, Tex.	7	R. R. Krezdorn
Texas Western College, El Paso, Tex.	7	Floyd A. Decker
*Toledo, University of, Toledo, Ohio	11	D. J. Ewing
*Toronto, University of, Toronto, Ont., Canada	10	J. E. Reid
*Tufts College, Medford, Mass.	1	David E. Higginbotham
*Tulane University, New Orleans, La.	4	Robert L. Drake
Union College, Schenectady, N. Y.	1	O. G. Owens
United States Naval Academy, Annapolis, Md.	2	W. K. Kay
United States Naval Post Graduate School, Monterey, Calif.	8	Charles B. Oler
*Utah, University of, Salt Lake City, Utah	9	R. E. Stephenson
Vanderbilt University, Nashville, Tenn.	4	Walter Criley
*Vermont, University of, Burlington, Vt.	1	Laurence F. Shorey
*Villanova College, Villanova, Pa.	2	John B. Clothier, Jr.
Virginia Military Institute, Lexington, Va.	4	Lee L. Nichols, Jr.
*Virginia Polytechnic Institute, Blacksburg, Va.	4	Claudius Lee
*Virginia, University of, Charlottesville, Va.	4	J. M. Roberts
*Washington, State College of, Pullman, Wash.	9	A. L. Betts
*Washington, University of, Seattle, Wash.	9	F. D. Robbins
*Washington University, St. Louis, Mo.	7	Marvin Gouro
*Wayne University, Detroit, Mich.	5	Richard E. Kuba
*West Virginia University, Morgantown, W. Va.	2	Everette C. Dubbe
*Wisconsin, University of, Madison, Wis.	5	W. B. Swift
*Worcester Polytechnic Institute, Worcester, Mass.	1	W. R. Grogan
*Wyoming, University of, Laramie, Wyo.	6	R. K. Beach
*Yale University, New Haven, Conn.	1	J. C. May
Youngstown University, Youngstown, Ohio	2	Eugene A. Klingshirn

* Joint AIEE–IRE Branches..................106

† Affiliate Branches..................12

Total Branches..................152

Committees Reorganized Under Five New Departments

THE GENERAL COMMITTEES will take on new and greater responsibilities in the operation of the Institute. Grouped into five Departments, the traditional 25 standing committees will be represented at the Directors' meetings and will act, under departmental co-ordination, to implement Institute policy. The Board of Directors, long overburdened, will thus free itself for concentration on establishing and defining policy.

The decision to set up the new organizational plan was taken at the June meeting of the Board. Chairman L. F. Hickernell of the Planning and Co-ordination Committee explained that the idea has been thoroughly tested over the past five years in the technical committees which have been co-ordinated in the Committee on Technical Operations which now becomes the Technical Operations Department. Mr. Hickernell traced the development of the present plan over the past two years.

On June 24, 1954, the Board of Directors authorized the Committee on Planning and Co-ordination:

> "To conduct an over-all study of the present organization of the Institute, including its finances, . . . made with a view to arriving at a more efficient and comprehensive plan of organization designed to operate within the available finances of the Institute and to provide for such subdivisions as may be needed for the efficient administration of the affairs of the Institute in the future..."

Later, the Committee was authorized to retain the services of Stevenson, Jordan, and Harrison, Inc., Management Consultants, to assist in this assignment.

After two years of intensive effort, personal interviews with groups of members and nonmembers by the Consultants, 10 all-day Committee Meetings, considerable exchange of correspondence among Committee members, the Committee recommended a modified version of the Organization suggested by the Management Consultants.

As inevitable in a democratic organization of voluntary members, this plan was in turn modified during discussion and action at two meetings of the Board of Directors. The organization as adopted finally for the administrative year 1956–57 is that shown in the accompanying Organization Chart.

DEPARTMENTS

Essentially, the revised organization will consist of 5 Operating Departments in addition to the established Districts and Sections Organization. Within each Department are grouped the existing General Committees of related interest in a manner similar to the organization of the former Committee on Technical Operations which was formed in 1951.

A Department Chairman, together with the Chairmen of the General Committees, will supervise the activities of its Committees and groups, particularly in matters of co-ordination and execution of programs assigned to or developed by them.

The delegation of responsibility and authority for administration and operation of these Departments under policies approved by the Board of Directors is expected to relieve the Board of much operating detail, thus, enabling it to devote its time and energy to the development of long-range policies.

The Chairmen of these Departments are authorized to attend Board Meetings and participate in discussions leading to policy making, without vote unless elected members of the Board.

DIVISIONS

The Technical Operations Department will consist of 6 (Technical) Divisions and the Research, Safety, and Standards Committees. The Education, Management, and Prize Awards Committees, members of the former Committee on Technical Operations, will be transferred to the new Professional Development and Recognition Department. Otherwise, this Department (formerly Committee) will continue to operate as it has since its formation in 1951 with a few added responsibilities such as the scheduling of General and District Meetings in addition to Special Technical Conferences.

DEPARTMENT AND COMMITTEE DUTIES

New and/or revised scopes of the Departments and Committees have been approved by the Board of Directors and will be included in the published Bylaws.

TECHNICAL GROUPS

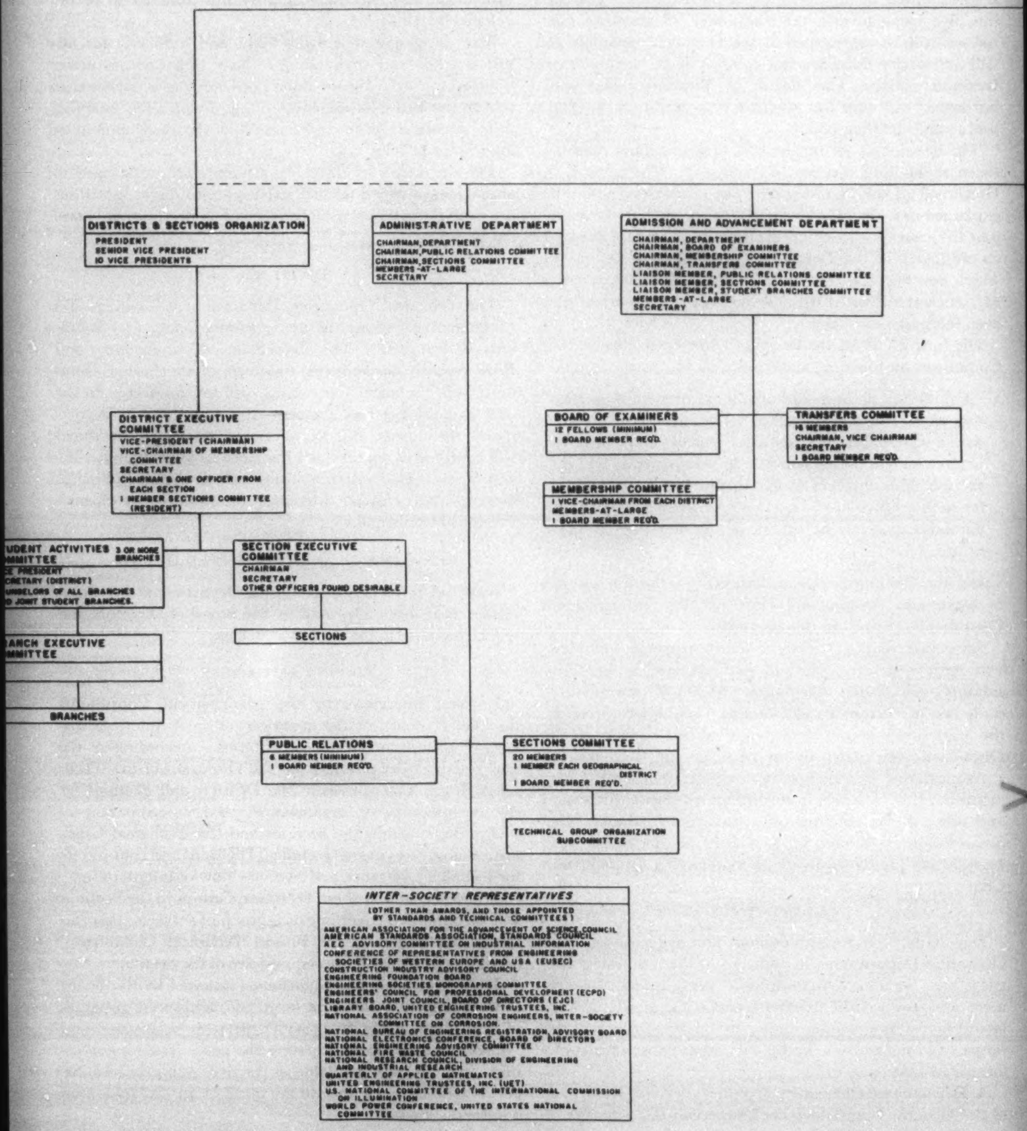
Personal interviews by the Management Consultants disclosed a desire of the members for small informal discussion groups on technical subjects. Accordingly, the new organization provides for the formation of (a) Technical Group Committees in the Districts and Sections for the encouragement, organization, and co-ordination of such groups, within the Sections and (b) Technical Guidance Committees in the Technical Divisions and committees for technical assistance and two-way flow of information.

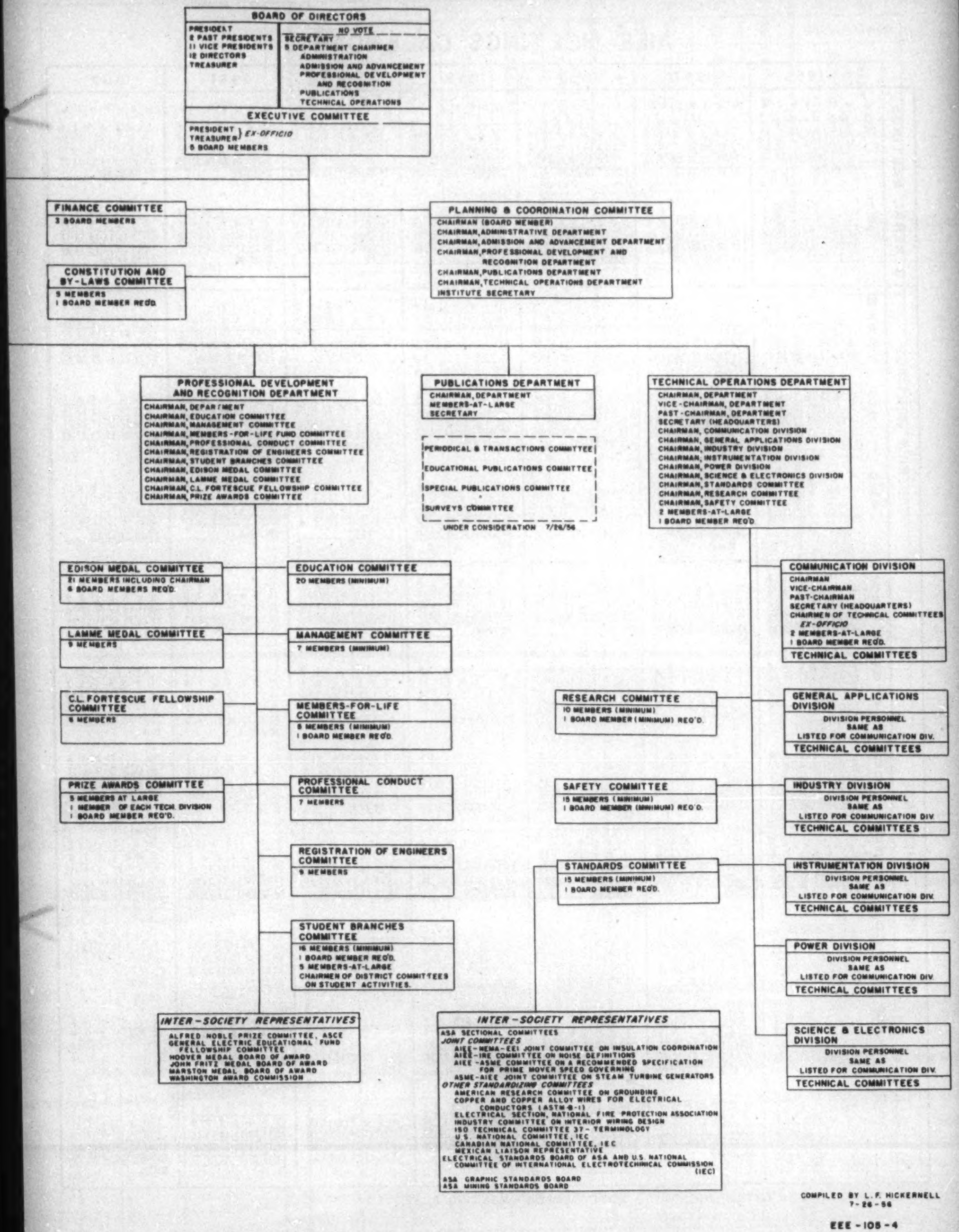
It is expected that these Technical Groups in the Sections will be formed to cover one or a group of subjects conforming to the scopes of the 50-odd Technical Committees, according to the local interest and size of the Section.

These organizational adjustments initiated by the Board of Directors are a part of a large and continuing program of study and action to provide effective "feedback" and "quick response" in anticipating the needs of the membership and making available attractive opportunities for participation by the individual member in the Institute's program.

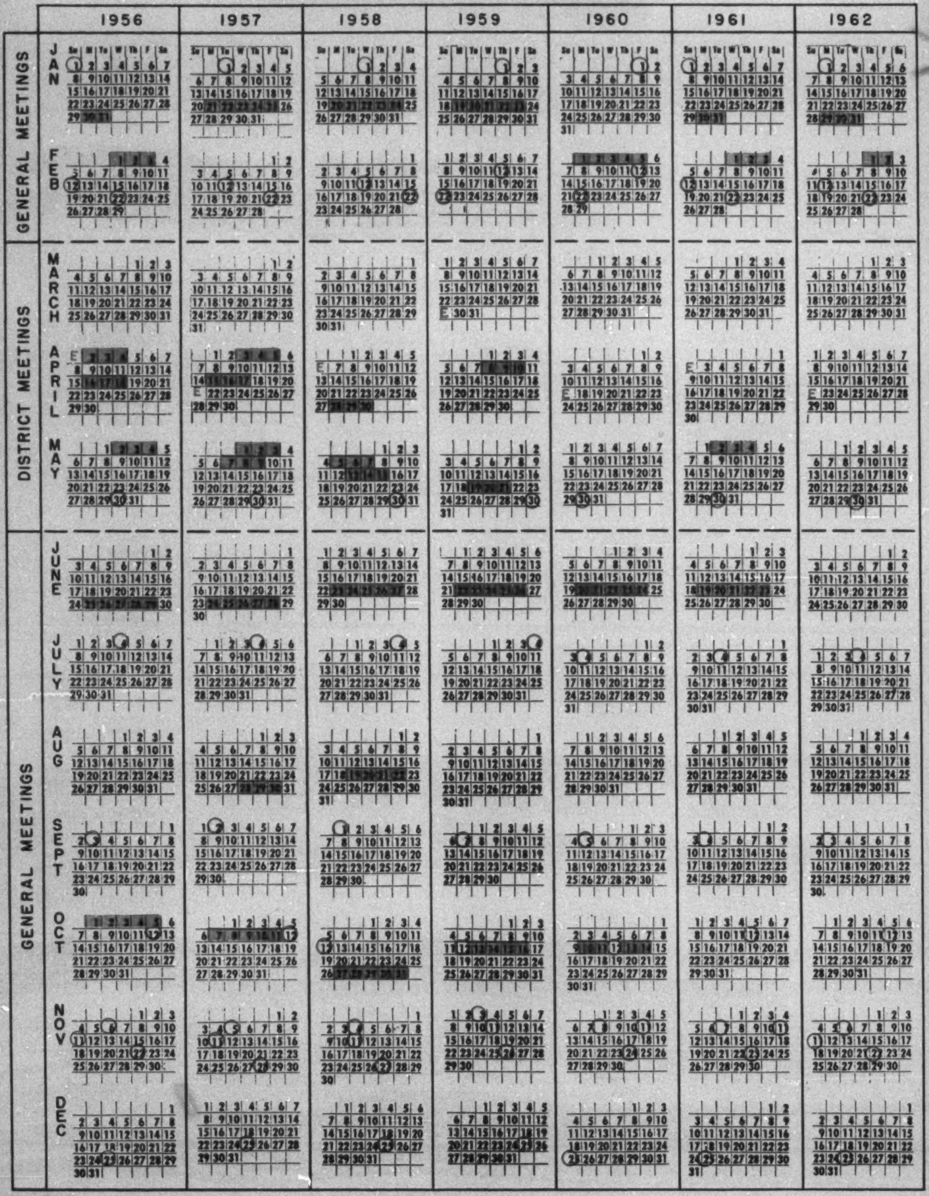
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

ORGANIZATION CHART — 1956-1957


DISTRICTS & SECTIONS ORGANIZATION
PRESIDENT
SENIOR VICE PRESIDENT
10 VICE PRESIDENTS
ADMINISTRATIVE DEPARTMENT
CHAIRMAN, DEPARTMENT
CHAIRMAN, PUBLIC RELATIONS COMMITTEE
CHAIRMAN, SECTIONS COMMITTEE
MEMBERS-AT-LARGE
SECRETARY
ADMISSION AND ADVANCEMENT DEPARTMENT
CHAIRMAN, DEPARTMENT
CHAIRMAN, BOARD OF EXAMINERS
CHAIRMAN, MEMBERSHIP COMMITTEE
CHAIRMAN, TRANSFERS COMMITTEE
LIAISON MEMBER, PUBLIC RELATIONS COMMITTEE
LIAISON MEMBER, SECTIONS COMMITTEE
LIAISON MEMBER, STUDENT BRANCHES COMMITTEE
MEMBERS-AT-LARGE
SECRETARY
DISTRICT EXECUTIVE COMMITTEE
VICE-PRESIDENT (CHAIRMAN)
VICE-CHAIRMAN OF MEMBERSHIP COMMITTEE
SECRETARY
CHAIRMAN & ONE OFFICER FROM EACH SECTION
1 MEMBER SECTIONS COMMITTEE (RESIDENT)
BOARD OF EXAMINERS
12 FELLOWS (MINIMUM)
1 BOARD MEMBER REQ'D.
TRANSFERS COMMITTEE
16 MEMBERS
CHAIRMAN, VICE CHAIRMAN
SECRETARY
1 BOARD MEMBER REQ'D.
MEMBERSHIP COMMITTEE
1 VICE-CHAIRMAN FROM EACH DISTRICT
MEMBERS-AT-LARGE
1 BOARD MEMBER REQ'D.
UDENT ACTIVITIES
MMITTEE
3 OR MORE BRANCHES
CE PRESIDENT
CRETARY (DISTRICT)
UNSELORS OF ALL BRANCHES
D JOINT STUDENT BRANCHES.
SECTION EXECUTIVE COMMITTEE
CHAIRMAN
SECRETARY
OTHER OFFICERS FOUND DESIRABLE
SECTIONS
ANCH EXECUTIVE
MMITTEE
BRANCHES
PUBLIC RELATIONS
6 MEMBERS (MINIMUM)
1 BOARD MEMBER REQ'D.
SECTIONS COMMITTEE
20 MEMBERS
1 MEMBER EACH GEOGRAPHICAL DISTRICT
1 BOARD MEMBER REQ'D.
TECHNICAL GROUP ORGANIZATION SUBCOMMITTEE
INTER-SOCIETY REPRESENTATIVES
(OTHER THAN AWARDS, AND THOSE APPOINTED BY STANDARDS AND TECHNICAL COMMITTEES)
AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, COUNCIL
AMERICAN STANDARDS ASSOCIATION, STANDARDS COUNCIL
AEC ADVISORY COMMITTEE ON INDUSTRIAL INFORMATION
CONFERENCE OF REPRESENTATIVES FROM ENGINEERING SOCIETIES OF WESTERN EUROPE AND USA (EUSEC)
CONSTRUCTION INDUSTRY ADVISORY COUNCIL
ENGINEERING FOUNDATION BOARD
ENGINEERING SOCIETIES MONOGRAPHS COMMITTEE
ENGINEERS' COUNCIL FOR PROFESSIONAL DEVELOPMENT (ECPD)
ENGINEERS JOINT COUNCIL, BOARD OF DIRECTORS (EJC)
LIBRARY BOARD, UNITED ENGINEERING TRUSTEES, INC.
NATIONAL ASSOCIATION OF CORROSION ENGINEERS, INTER-SOCIETY COMMITTEE ON CORROSION.
NATIONAL BUREAU OF ENGINEERING REGISTRATION, ADVISORY BOARD
NATIONAL ELECTRONICS CONFERENCE, BOARD OF DIRECTORS
NATIONAL ENGINEERING ADVISORY COMMITTEE
NATIONAL FIRE WASTE COUNCIL
NATIONAL RESEARCH COUNCIL, DIVISION OF ENGINEERING AND INDUSTRIAL RESEARCH
QUARTERLY OF APPLIED MATHEMATICS
UNITED ENGINEERING TRUSTEES, INC. (UET)
U.S. NATIONAL COMMITTEE OF THE INTERNATIONAL COMMISSION ON ILLUMINATION
WORLD POWER CONFERENCE, UNITED STATES NATIONAL COMMITTEE


BOARD OF DIRECTORS
PRESIDENT
2 PAST PRESIDENTS
11 VICE PRESIDENTS
12 DIRECTORS
TREASURER
NO VOTE
SECRETARY
5 DEPARTMENT CHAIRMEN
ADMINISTRATION
ADMISSION AND ADVANCEMENT
PROFESSIONAL DEVELOPMENT AND RECOGNITION
PUBLICATIONS
TECHNICAL OPERATIONS
EXECUTIVE COMMITTEE
PRESIDENT
TREASURER
EX-OFFICIO
5 BOARD MEMBERS
FINANCE COMMITTEE
3 BOARD MEMBERS
CONSTITUTION AND BY-LAWS COMMITTEE
5 MEMBERS
1 BOARD MEMBER REQ'D.
PLANNING & COORDINATION COMMITTEE
CHAIRMAN (BOARD MEMBER)
CHAIRMAN, ADMINISTRATIVE DEPARTMENT
CHAIRMAN, ADMISSION AND ADVANCEMENT DEPARTMENT
CHAIRMAN, PROFESSIONAL DEVELOPMENT AND RECOGNITION DEPARTMENT
CHAIRMAN, PUBLICATIONS DEPARTMENT
CHAIRMAN, TECHNICAL OPERATIONS DEPARTMENT
INSTITUTE SECRETARY
PROFESSIONAL DEVELOPMENT AND RECOGNITION DEPARTMENT
CHAIRMAN, DEPARTMENT
CHAIRMAN, EDUCATION COMMITTEE
CHAIRMAN, MANAGEMENT COMMITTEE
CHAIRMAN, MEMBERS-FOR-LIFE FUND COMMITTEE
CHAIRMAN, PROFESSIONAL CONDUCT COMMITTEE
CHAIRMAN, REGISTRATION OF ENGINEERS COMMITTEE
CHAIRMAN, STUDENT BRANCHES COMMITTEE
CHAIRMAN, EDISON MEDAL COMMITTEE
CHAIRMAN, LAMME MEDAL COMMITTEE
CHAIRMAN, C.L. FORTESCUE FELLOWSHIP COMMITTEE
CHAIRMAN, PRIZE AWARDS COMMITTEE
PUBLICATIONS DEPARTMENT
CHAIRMAN, DEPARTMENT
MEMBERS-AT-LARGE
SECRETARY
PERIODICAL & TRANSACTIONS COMMITTEE
EDUCATIONAL PUBLICATIONS COMMITTEE
SPECIAL PUBLICATIONS COMMITTEE
SURVEYS COMMITTEE
UNDER CONSIDERATION 7/26/56
TECHNICAL OPERATIONS DEPARTMENT
CHAIRMAN, DEPARTMENT
VICE-CHAIRMAN, DEPARTMENT
PAST-CHAIRMAN, DEPARTMENT
SECRETARY (HEADQUARTERS)
CHAIRMAN, COMMUNICATION DIVISION
CHAIRMAN, GENERAL APPLICATIONS DIVISION
CHAIRMAN, INDUSTRY DIVISION
CHAIRMAN, INSTRUMENTATION DIVISION
CHAIRMAN, POWER DIVISION
CHAIRMAN, SCIENCE & ELECTRONICS DIVISION
CHAIRMAN, STANDARDS COMMITTEE
CHAIRMAN, RESEARCH COMMITTEE
CHAIRMAN, SAFETY COMMITTEE
2 MEMBERS-AT-LARGE
1 BOARD MEMBER REQ'D
EDISON MEDAL COMMITTEE
21 MEMBERS INCLUDING CHAIRMAN
6 BOARD MEMBERS REQ'D.
EDUCATION COMMITTEE
20 MEMBERS (MINIMUM)
LAMME MEDAL COMMITTEE
9 MEMBERS
MANAGEMENT COMMITTEE
7 MEMBERS (MINIMUM)
C.L. FORTESCUE FELLOWSHIP COMMITTEE
6 MEMBERS
MEMBERS-FOR-LIFE COMMITTEE
8 MEMBERS (MINIMUM)
1 BOARD MEMBER REQ'D.
PRIZE AWARDS COMMITTEE
5 MEMBERS AT LARGE
1 MEMBER OF EACH TECH. DIVISION
1 BOARD MEMBER REQ'D.
PROFESSIONAL CONDUCT COMMITTEE
7 MEMBERS
REGISTRATION OF ENGINEERS COMMITTEE
9 MEMBERS
STUDENT BRANCHES COMMITTEE
16 MEMBERS (MINIMUM)
1 BOARD MEMBER REQ'D.
5 MEMBERS-AT-LARGE
CHAIRMEN OF DISTRICT COMMITTEES ON STUDENT ACTIVITIES.
INTER-SOCIETY REPRESENTATIVES
ALFRED NOBLE PRIZE COMMITTEE, ASCE
GENERAL ELECTRIC EDUCATIONAL FUND FELLOWSHIP COMMITTEE
HOOVER MEDAL BOARD OF AWARD
JOHN FRITZ MEDAL BOARD OF AWARD
MARSTON MEDAL BOARD OF AWARD
WASHINGTON AWARD COMMISSION
COMMUNICATION DIVISION
CHAIRMAN
VICE-CHAIRMAN
PAST-CHAIRMAN
SECRETARY (HEADQUARTERS)
CHAIRMEN OF TECHNICAL COMMITTEES
EX-OFFICIO
2 MEMBERS-AT-LARGE
1 BOARD MEMBER REQ'D.
TECHNICAL COMMITTEES
RESEARCH COMMITTEE
10 MEMBERS (MINIMUM)
1 BOARD MEMBER (MINIMUM) REQ'D.
GENERAL APPLICATIONS DIVISION
DIVISION PERSONNEL SAME AS LISTED FOR COMMUNICATION DIV.
TECHNICAL COMMITTEES
SAFETY COMMITTEE
15 MEMBERS (MINIMUM)
1 BOARD MEMBER (MINIMUM) REQ'D.
INDUSTRY DIVISION
DIVISION PERSONNEL SAME AS LISTED FOR COMMUNICATION DIV.
TECHNICAL COMMITTEES
STANDARDS COMMITTEE
15 MEMBERS (MINIMUM)
1 BOARD MEMBER REQ'D.
INSTRUMENTATION DIVISION
DIVISION PERSONNEL SAME AS LISTED FOR COMMUNICATION DIV.
TECHNICAL COMMITTEES
POWER DIVISION
DIVISION PERSONNEL SAME AS LISTED FOR COMMUNICATION DIV.
TECHNICAL COMMITTEES
INTER-SOCIETY REPRESENTATIVES
ASA SECTIONAL COMMITTEES
JOINT COMMITTEES
AIEE-NEMA-EEI JOINT COMMITTEE ON INSULATION COORDINATION
AIEE-IRE COMMITTEE ON NOISE DEFINITIONS
AIEE-ASME COMMITTEE ON A RECOMMENDED SPECIFICATION FOR PRIME MOVER SPEED GOVERNING
ASME-AIEE JOINT COMMITTEE ON STEAM TURBINE GENERATORS
OTHER STANDARDIZING COMMITTEES
AMERICAN RESEARCH COMMITTEE ON GROUNDING
COPPER AND COPPER ALLOY WIRES FOR ELECTRICAL CONDUCTORS (ASTM-B-1)
ELECTRICAL SECTION, NATIONAL FIRE PROTECTION ASSOCIATION
INDUSTRY COMMITTEE ON INTERIOR WIRING DESIGN
ISO TECHNICAL COMMITTEE 37 - TERMINOLOGY
U.S. NATIONAL COMMITTEE, IEC
CANADIAN NATIONAL COMMITTEE, IEC
MEXICAN LIAISON REPRESENTATIVE
ELECTRICAL STANDARDS BOARD OF ASA AND U.S. NATIONAL COMMITTEE OF INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)
ASA GRAPHIC STANDARDS BOARD
ASA MINING STANDARDS BOARD
SCIENCE & ELECTRONICS DIVISION
DIVISION PERSONNEL SAME AS LISTED FOR COMMUNICATION DIV.
TECHNICAL COMMITTEES
COMPILED BY L. F. HICKERNELL
7-26-56
EEE-108-4

AIEE MEETINGS CALENDAR


1956
1957
1958
1959
1960
1961
1962
GENERAL MEETINGS
DISTRICT MEETINGS
GENERAL MEETINGS
JAN
FEB
MARCH
APRIL
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
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E-EASTER, CIRCLED DATES-HOLIDAYS, BOXED DATES-MEETING SCHEDULES.

MEETING	DESIGNATION	NAME OF MEETING	CONVENTIONAL SCHEDULE	1956			1957			1958			1959			1960			1961			1962			INVITATIONS	
				DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION	PAPER CLOSING	DATE	LOCATION
GENERAL	WG	WINTER	JAN. 4 TH WK.	JAN. 30 FEB. 3	NEW YORK N.Y.	CLOSED	JAN. 21-25	NEW YORK N.Y.	OCT. 21 1956	JAN. 20-24	NEW YORK N.Y.	OCT. 20 1957	JAN. 19-23	NEW YORK N.Y.	OCT. 20 1958	FEB. 1-5	NEW YORK N.Y.	OCT. 20 1959	JAN. 30- FEB. 3.	NEW YORK N.Y.	OCT. 20 1960	JAN. 29 FEB. 2	NEW YORK N.Y.		63 64 65	1/28-2/1 2/3-2/7 1/31-2/5 OR 2/7-2/12 NEW YORK N.Y.
	SG	SUMMER	JUNE 3 RD. 4 TH. WK.	JUNE 25-29	SAN FRANCISCO CALIF.	CLOSED	JUNE 24-28	MONTREAL QUEBEC	MAR. 27 1957	JUNE 23-27	BUFFALO N.Y.	MAR. 21 1958	JUNE 22-26	SEATTLE WASHINGTON	MAR. 20 1959	JUNE 20-24	ATLANTIC CITY N.J.	MAR. 18 1960	JUNE 19-23	ITHACA N.Y.	MAR. 17 1961		DENVER COLO		63 64	TORONTO LOS ANGELES
	PG	PACIFIC	AUG.				AUG. 28-30	PASCO WASHINGTON	MAY 28 1957	AUG. 19-22	SACRAMENTO CALIF.	MAY 19 1958					SAN DIEGO CALIF.								61	SALT LAKE CITY
	FG	FALL	OCT.	OCT. 1-5	CHICAGO ILL.	CLOSED	OCT. 7-11	CHICAGO ILL.	JUNE 7 1957	OCT. 27-31	PITTSBURGH PA.	JUNE 27 1958	OCT 12-16	CHICAGO ILL.	JUNE 12 1959	OCT. 10-14	CHICAGO ILL.	JUNE 10 1960							61 62,3	CLEVELAND DETROIT CINCINNATI CLEVELAND
DISTRICT	DI	NORTH EASTERN	EARLY MAY	MAY 2-4	ROCHESTER N.Y.	CLOSED	MAY 1-3	PITTSFIELD MASS.	FEB. 1 1957		(SGM)			SYRACUSE N.Y.						(SGM)						
	D2	MIDDLE EASTERN	MAY							APR 28-30	WASHINGTON DC	JAN. 28 1958	MAY 19-21	BALTIMORE MD.	FEB. 19 1959		(SGM)		MAY 2-4	PITTSBURGH PA.	FEB. 2 1961					
	D4	SOUTHERN	LATE MAR. EARLY APR.				APR. 3-5	JACKSON MISS.	JAN. 3 1957				APR. 8-10	ATLANTA GA.	JAN. 8 1959				AFTER APR. 2	NEW ORLEANS LA.						
	D5	GREAT LAKES	LATE APRIL	APR. 16-18	FT. WAYNE INDIANA	CLOSED	APR. 15-17	DES MOINES IOWA	JAN. 15 1957	MAY 5-7	M.S.U. E.LANSING MICH.	FEB. 5 1958														
	D7	SOUTH WEST	LATE MAR. EARLY APR.	APR. 2-4	DALLAS TEXAS	CLOSED				MAR.31 APR.2																
	DII	EAST CENTRAL	EARLY MAY				MAY 7-9	DAYTON OHIO	FEB. 7 1957	MAY 13-15	HUNTINGTON W. VA.	FEB. 13 1958	APR. (LATE)	AKRON OHIO		MAY	CHARLESTON W. VA									
EASTER				APRIL 1			APRIL 21			APRIL 6			MARCH 29			APRIL 17			APRIL 2			APRIL 22				

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS
COMMITTEE ON PLANNING & COORDINATION

1956 - 1962
SCHEDULE OF
GENERAL & DISTRICT MEETINGS

ISSUED BY:
L.F. HICKERNELL
CHAIRMAN

ISSUE NO: 5
DATE: 7-16-56
DWG. NO. EEB-100

Schedule of Special Technical Conferences 1956-1957

Date	Conference and Location	Sponsors	Closing Date of TP
1956:			
Sept. 17–19	Petroleum Industry—Kansas City, Mo., Muehlebach Hotel	Petroleum Industry Committee, AIEE	Closed
Sept. 17–21	Instrument-Automation and Exhibit—New York, N. Y., New York Coliseum	AIEE-ISA	Closed
Sept. 24–25	Industrial Electronics—Cleveland, Ohio, Hotel Manger	Feedback Control Committee, AIEE-IRE-PGIE-PGPT	Closed
Oct. 1– 3	National Electronics—Chicago, Ill., Hotel Sherman	AIEE-IIT-IRE-NU-UofI	Closed
Oct. 16–18	Magnetism and Magnetic Materials—Boston, Mass., Hotel Statler	Magnetics Subcommittee of Basic Sciences Committee, AIEE-IRE	Closed
Oct. 19	Combustion Control—Norwich, Conn., Norwich Inn and Country Club	AIEE–ASME	Closed
Oct. 22–24	Machine Tools—Cincinnati, Ohio, Hotel Sheraton-Gibson	Machine Tool Subcommittee of GIA Committee, AIEE	Closed
Oct. 29-31	Farm Electrification—Memphis, Tenn.	Farm Electrification Subcommittee of D and CA Committee, AIEE	Closed
Nov. 1– 2	Fall Textile—Raleigh, N. C., North Carolina State College	Subcommittee on Textile Industry of GIA Committee, AIEE	Closed
Nov. 7– 9	Electrical Techniques in Medicine and Biology—New York, N. Y., McAlpin Hotel	AIEE-IRE-ISA	Closed
Dec. 10–12	Eastern Joint Computer—New York, N. Y., Hotel New Yorker	AIEE-IRE-ACM	Sept. 10
1957:			
Jan. 14–15	Symposium on Reliability and Quality Control—Washington, D. C., Hotel Statler	AIEE-IRE-RETMA	Oct. 15
Feb. 26–28	Western Joint Computer—Los Angeles, Calif., Hotel Statler	AIEE-IRE-ACM	Nov. 26
Mar. 7– 8	Textile—Atlanta, Ga., Georgia Tech.	Subcommittee on Textile Industry of GIA Committee, AIEE	Dec. 7
Mar. 10–16	Nuclear Congress—Philadelphia, Pa., Philadelphia Coliseum	ASCE-AIEE-AIME-AIChE-EJC	Dec. 13
Mar. 27–28	Engineering Management—Pittsburgh, Pa.	AIEE-ASME	Dec. 27
Mar. 28–29	Paper and Pulp—Atlanta, Ga., Georgia Tech.	Subcommittee on Paper and Pulp of GIA Committee, AIEE	Dec. 28
Apr. 4– 8	Welding—Philadelphia, Pa.	AIEE-AWS	Jan. 4
Apr. 8– 9	Rubber and Plastics—Akron, Ohio	R and P Subcommittee of GIA Committee, AIEE	Jan. 8
Apr. 23–24	Electric Heating—Toledo, Ohio, Commodore Perry Hotel	Electric Heating Committee, AIEE	Jan. 23
May 1– 3	Electronic Components—Chicago, Ill., Morrison Hotel	AIEE-IRE	Feb. 1
May 7– 9	Aircraft Electrical Equipment	AIEE Air Transportation Committee	Feb. 7
May 27–29	National Telemetering—Chicago, Ill., Morrison Hotel	AIEE-IRE-ISA-IAS	Feb. 27
Sept. 4– 5	Magnetic Amplifiers	Magnetic Amplifier Committee, AIEE	June 4
Nov. 4– 6	Machine Tool—Milwaukee, Wis.	AIEE	Aug. 5
Dec. 8–11	Eastern Joint Computer—Washington, D. C., Shoreham Hotel	AIEE-IRE-ACM	Sept. 9

(*Continued from page 840*)

Society of Civil Engineers, American Society of Mechanical Engineers, and American Institute of Chemical Engineers, and the dean of engineering who serves as ex-officio chairman of the board.

ECPD Will Hold 24th Annual Meeting in October

The 24th Annual meeting of Engineers' Council for Professional Development (ECDP) will be held October 25–26, 1956, in Detroit, Mich.

The meetings, through the courtesy of the Engineering Society of Detroit, will be held at their headquarters, 100 Farnsworth Avenue, Detroit, Mich. The two luncheons also will be held there.

Hotel headquarters will be the Statler Hotel, where the annual dinner and the buffet supper will be held.

An interesting program for the ladies, which will most likely include a trip to the new General Motors development and a view of the highlights of the city of Detroit, is in preparation.

The tentative program for the first day of the meeting is as follows:

Thursday, October 25

9:00 a.m. Registration

Delivery of tickets for program events, Engineering Society of Detroit (ESD), Rackham Building

9:30 a.m. Open Council Meeting—Auditorium, ESD

Presiding: Thorndike Saville, president, ECPD

"Welcome to Detroit"

Meeting turned back to Mr. Saville who will make announcements concerning the program, conference theme, and other remarks and will turn the meeting over to George Porter, chairman, Sponsoring Group, Detroit, Mich.

9:50 a.m.

"Objectives of the Five Year Plan in Detroit." Mr. Porter

10:10 a.m.

Talk on "Orientation and Training of College Graduate Engineers." Stresses need for general objectives and administration of, rather than details of particular plans. Also discusses the need for appraisal of young engineers not only during the training period, but during the whole first five years.

10:35 a.m.

Talk on "The Place of Continued Education Plans in Detroit Industry." Also brings out points in connection with Selected Reading.

11:00 a.m.

Talk on "Professional Identification." Stresses the value of this, perhaps outlining plans of some companies with respect to membership, attending conferences, etc. Also includes comments on the points of integration into the community and some ways this may be accomplished.

11:25 a.m.

Summary by Mr. Porter of morning talks and comments on the work of the Detroit Committee in connection with these points.

12:00 Noon Luncheon—Banquet Hall, ESD

Speaker: Dr. Kenneth McFarland, industrial consultant

1:30–2:30 p.m. Work Shops

(1) Orientation, Training, and Appraisal
(2) Continued Education and Selected Reading
(3) Professional Identification and Integration into the Community

2:45–3:15 p.m.

Joint meeting of all Work Shop Committees summarizing discussions in the Work Shops and answering questions concerning the Detroit Project.

3:30 p.m. Administration Session

5:45–6:30 p.m. Reception—Bagley Room, Hotel Statler

6:30 p.m. Annual ECPD Dinner—Wayne Room, Hotel Statler

Speaker: J. H. Foote

J. J. Jaklitsch Named Acting Editor of *Mechanical Engineering*

J. J. Jaklitsch, Jr., a member of the editorial staff of The American Society of Mechanical Engineers (ASME) since 1945, has been named acting editor of *Mechanical Engineering*. He will also be responsible for other periodical publications of the ASME, Transactions and *Journal of Applied Mechanics*, as well as individually published technical papers.

During his carrer, Mr. Jaklitsch has been a contributing editor to "The American Year Book" and "Collier's Year Book." Before joining the editorial staff of the ASME, he was employed by the U. S. Army Ordnance Department in both an engineering and editorial capacity.

He is a member of ASME, the Society of Business Magazine Editors, the New York Business Paper Editors, and the Engineers' Club of New York.

ESPS Board of Directors and Branch Managers Hold Meeting

For the first time in its 38 years of existence, the Managers of the branch offices of the Engineering Societies Personnel Service (ESPS), Inc., met with the members of the Board of Directors for a two-day meeting in New York City at the Engineering Societies Building, 29 West 39th Street, New York, N. Y.

The purpose of the meeting was to discuss and devise ways and means to meet the changing employment conditions in the engineering field.

A number of important national policy changes in ESPS, Inc. operations will be inaugurated as a result of this meeting and it is hoped that these changes will permit the Service to continue to serve the profession as it has done so well in the past.

C. F. Kettering To Be Honored During 1956 Fall General Meeting

The Fall General Meeting of the AIEE has been chosen as the occasion when the engineering profession, as represented by the major societies, will observe the 80th birthday of C. F. Kettering, the inventor of the automobile engine electric starter and the inspiration for a long list of important developments in the mechanical, automotive, chemical, and metallurgical fields.

Mr. Kettering (AM '04, F '14, Member for Life), will be honored at a luncheon on Thursday, October 4, 1956, at the Morrison Hotel, Chicago, Ill., as a part of the Fall General Meeting.

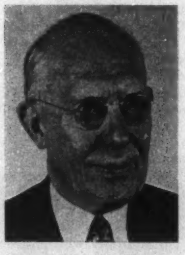
The AIEE is privileged to make this initial presentation of the award, which is planned to be an annual affair, as Mr. Kettering was graduated as an electrical engineer and the AIEE was the first engineering society he joined.

It is contemplated that the award will be made by the societies representing the many fields of Mr. Kettering's interests and will be made ". . . for creative accomplishment for the benefit of mankind, including discovery, invention, improvement in design or processing, involving the relationship between materials and energy."

A director and former vice-president of General Motors (GM) and former general manager of the GM Research Laboratories, Mr. Kettering was born on a farm near Loudonville, Ohio, on August 29, 1876. At present, having retired June 2, 1947, as head of the GM Research Laboratories, he retains the status of research consultant.

After graduation from Ohio State University in 1904, he became associated with the inventions department of the National Cash-Register Company at Dayton, Ohio, where he developed an electric drive for the cash register.

In 1909, Mr. Kettering organized the Dayton Engineering Laboratories Company where he invented the electric starting, lighting, and ignition systems for the automobile. In 1916, he established a research laboratory at Dayton which was taken over by the GM Corporation in 1920, and moved to Detroit, Mich., in 1925 at which time he also joined GM.


C. F. Kettering

Mr. Kettering has received honorary degrees from over 30 colleges and universities, including University of Cincinnati, Brown University, New York University, Dartmouth College, Harvard University, Columbia University, Polytechnic Institute of Brooklyn, Worcester Polytechnic Institute, and Princeton University. He has been the recipient of numerous medals and awards, among which are the Washington Award, 1936; Franklin Gold Medal, 1936; American Society of Mechanical Engineers Medal, 1940; John Fritz Medal, 1944; Thomas A. Edison Award, 1945; Gold Medal of the International Benjamin Franklin Society, 1949; and the National Society of Professional Engineers Award, 1953.

Mr. Kettering holds honorary and life memberships in many societies, including the National Academy of Sciences, Society of Automotive Engineers, The Franklin Institute, American Society for Steel Treating, American Philosophical Society, American Hospital Association, and Engineering Society of Cincinnati.

Courtesy Ross Photos

BRANCH MANAGERS of Engineering Societies Personnel Service, Inc., during the meeting held recently in New York, N. Y. are (*left to right*) Bonnell Allen, manager, Chicago, Ill. office; Frank McKinless, manager, Detroit, Mich. office; A. H. Meyer, executive director; Joseph Decker, manager, San Francisco, Calif. office; and George Parker, manager, New York, N. Y. office.

NEC Will Feature 24 Technical Sessions

Highlighting the 1956 National Electronics Conference (NEC) at the Hotel Sherman in Chicago, Ill., October 1–3, will be 24 technical sessions and three luncheon addresses of general interest.

The tentative program for the 12th annual conference features approximately 100 papers on electronic research, development, and application, according to L. T. De Vore, program chairman.

More than 10,000 persons are expected to attend the three-day technical meeting and exhibition having "Fifty Years of Progress through Electronics" as its theme.

Principal addresses will be given by Dr. J. P. Hagen director of the "Vanguard" project at the Naval Research Laboratory; Dr. F. L. Hovde, president of Purdue University; and Dr. Herbert Scoville Jr., assistant director of the U.S. Central Intelligence Agency.

Another feature of the conference will be three half-day educational sessions, dealing with information theory, radio isotopes, and solid state.

Chairmen of the educational sessions will be: Prof. R. M. Fano, Massachusetts Institute of Technology, information theory; Dr. Leonard Reiffel, Armour Research Foundation of Illinois Institute of Technology, radio isotopes; and J. P. Jordan, General Electric Company, solid state. A record 240 commercial exhibits also will be displayed at the conference. This is 54 more than the previous year.

Advance registrations are being accepted for the conference now. The $3 registration fee covers attendance at all technical sessions. Attendance at the various luncheons and the NEC party is optional. There is a special $19.50 rate which includes all conference activities.

Advance registrations may be made until September 15 through the Executive Secretary, National Electronics Conference, 84 E. Randolph St., Chicago 1, Ill. Reservations should be made directly with the hotel.

The NEC is sponsored annually by the AIEE, Institute of Radio Engineers, Illinois Institute of Technology, University of Illinois, and Northwestern University.

Also participating in the conference are Michigan State, Purdue, Michigan, and Wisconsin Universities, as well as the Radio-Electronics-Television Manufacturers Association and Society of Motion Picture and Television Engineers.

The tentative technical program is as follows:

Monday, October 1

Morning Session

Components and Materials
Instrumentation
Servomechanism Applications
Measurements I

Afternoon Session

Receiver Techniques
Data Storage Systems
Servomechanism Theory
Measurements II

Tuesday, October 2

Morning Session

Application of Information Theory
Magnetic Amplifiers
Solid State Devices and Applications I
Network and Filter Theory

Afternoon Session

Radio Isotopes
Data Processing Systems
Solid-State Devices and Applications II
Microwave

Wednesday, October 3

Morning Session

Solid State
High Power Audio Systems
Network Synthesis
Antennas

Afternoon Session

Quality Control and Reliability
Automation Techniques
Medical Electronics
Pulse Techniques

Sperry Award To Be Given to D. W. Douglas

D. W. Douglas, president, Douglas Aircraft Company, Inc., Santa Monica, Calif., has been selected to receive the 1956 Sperry Award for distinguished engineering contributions to the world's art of transportation.

Mr. Douglas was born in Brooklyn, N. Y., April 6, 1892. He entered the U. S. Naval Academy in 1909; however, an intense interest in aviation led to his resignation in 1912 to take up aeronautics at Massachusetts Institute of Technology. In 1915, he joined the Glenn L. Martin Company as chief engineer. A year later he became chief aeronautical engineer for the U. S. Signal Corps, returning to Martin as vice-president in 1917. In 1920, he went to California to form with D. R. Davis the organization that was the predecessor of Douglas Aircraft Company.

The award commemorates the interest and achievements in transportation of Dr. Elmer A. Sperry. The awards board is composed of four technical societies in which Dr. Sperry held office or membership—AIEE, American Society of Mechanical Engineers, Society of Automotive Engineers, and Society of Naval Architects and Marine Engineers.

COMMITTEE ACTIVITIES

Editor's Note: This department has been created for the convenience of the various AIEE technical committees and will include brief news reports of committee activities. Items for this department, which should be as short as possible, should be forwarded to R. S. Gardner at AIEE Headquarters, 33 West 39th Street, New York 18, N. Y.

Note: Because of the changeover in committee personnel, no items appear in this column this month.

AIEE PERSONALITIES

F. E. Terman

F. E. Terman (AM '23, F '45), provost of the University and dean of the School of Engineering, Stanford University, has been awarded the AIEE Members-for-Life Fund Medal in Electrical Engineering Education. The presentation will take place during the 1956 Fall General Meeting. Dean Terman was born in English, Ind., June 7, 1900. He was graduated from Stanford University with a bachelor of arts degree in 1920, and a degree in electrical engineering in 1922. In 1924, he received a doctorate in science from Massachusetts Institute of Technology. He has also been awarded honorary degrees by Harvard University, 1945; University of British Columbia, 1950; and Syracuse University, 1955. In 1925, Dean Terman joined the staff of Stanford University as an instructor in electrical engineering. He was made assisant professor in 1927, and associate professor in 1930. He became professor and head of the department of electrical engineering in 1937. In 1945, he was named dean of the School of Engineering, and in 1955, he became provost of the University. From 1942 to 1945, Dr. Terman was on leave from Stanford to direct the Radio Research Laboratory at Harvard University. This laboratory, set up by the Office of Scientific Research and Development, was the chief U. S. agency developing countermeasures against enemy radar during World War II. Dean Terman was decorated by the British Government in 1946, and received the Medal for Merit from the United States in 1948 for his war work. Dr. Terman is a contributor of articles to technical magazines and the author of several books, including "Transmission Line Theory," coauthored with W. S. Franklin; "Radio Engineering"; "Measurements in Radio Engineering"; "Fundamentals of Radio"; "Radio and Vacuum Tube Theory," in collaboration with U. S. Military Academy staff; "Radio Engineers' Handbook"; and "Electronic Measurements," in coauthorship with J. M. Pettit. He is affiliated with the following societies: National Academy of Sciences, National Research Council, Institute of Radio Engineers, American Physical Society, American Society for Engineering Education, American Association for the Advancement of Science, Sigma Xi, Tau Beta Pi, and Eta Kappa Nu. Dean Terman and his father, L. M. Terman, Stanford psychologist whose "IQ" tests and continuing studies of gifted children are world-famous, form one of the few father-son combinations in the National Academy of Sciences. Dean Terman has served on the following AIEE Committees: Electrophysics (1928–30), Communication (1934–42), Education (1935–43), Basic Sciences (1947–49), Research (1947–49) and Electronics (1955–56).

W. R. Clark (AM '37, M '44), chief engineer product engineering department, Leeds and Northrup Company, Philadelphia, Pa., has been named head of the AIEE Technical Operations Department, one of the five new Departments, approved by the Board of Directors, under which the Institute Committees have been reorganized. Mr. Clark was born in Trainer, Pa., November 28, 1907. He attended the University of Pennsylvania, receiving a bachelor of science degree in 1929, and master of science degree in 1932. The University has also awarded him a doctor of science degree. From 1929 to 1931, he worked as an electrical research engineer for Leeds and Northrup Company. In 1932, he became a member of the Museum staff of the Franklin Institute. Mr. Clark returned to the research department of Leeds and Northrup in 1934. He is a member of the Institute of Radio Engineers, American Physical Society, and the Franklin Institute. Mr. Clark has served on the following AIEE Committees: Electronics (1945–55); Instruments and Measurements (1947–55, chairman 1949–51); Technical Program (1949–50); Standards (1945–50); Science and Electronics Division (1949–56, chairman 1952–54); and Technical Operations (1952–56).

J. L. Callahan (M '35, F '48), assistant to the director, Radio Systems Research, RCA Laboratories Division, Radio Corporation of America (RCA), New York, N. Y., has been named head of the AIEE Admission and Advancement Department, one of the five new Departments approved by the Board of Directors. Mr. Callahan was born in Minneapolis, Minn., December 9, 1898. He received his early engineering training in Army electrical and signal schools, and later took a postgraduate course in radio engineering at Sorbonne University, Paris, France. In 1920, he became associated with the engineering department of RCA in communication research, and in 1930, he was made research section head in charge of the terminal facilities research laboratory. Since 1945, he has been assistant to the director, Radio Systems Research. Mr. Callahan is a Fellow of the Radio Club of America and the Institute of Radio Engineers. He served on the AIEE Board of Directors (1948–50) and has been a member of the following AIEE Committees: Communication (1941–49, chairman 1947–48); Communication and Science Co-ordinating Committee (1947–49); Standards (1947–48); Technical Program (1947–48, 1949–52); Executive Committee (1948–50); Edison Medal (1949–54); Communication Division (1949–52); Planning and Co-ordination (1950–52, 1954–56); Board of Examiners (1950–52); Joint AIEE-Institute of Radio Engineers Co-ordination Committee (April 1950–January 1951); General Electric Educational Fund Fellowship Committee (1951–54); Student Branches (1953–56); and Publication (1954–56).

W. S. Hill (AM '25, F '50), manager, Technical Recruiting Section, General Electric Company, Schenectady, N. Y., has been named head of the AIEE Publication Department, one of the five new Departments approved by the Board of Directors. Mr. Hill was born in Vicksburg, Mich., September 6, 1902. He was graduated from the University of Nevada in 1923 with a bachelor of science degree in electrical engineering. After graduation, he joined the General Electric Test Course in Schenectady, N. Y. In 1924, he became a member of the central station engineering department and in 1928, he transferred to the New York, N. Y., office as an application engineer. In 1939, he was made assistant district engineer and six years later became engineer of the Buffalo, N. Y., office. From 1945 to 1950, Mr. Hill was associated with Locke, Inc., as vice-president of engineering. In 1950, he again became associated with the General Electric Company. Mr. Hill was vice-president of District 1 (1952–54), and has served on the following AIEE Committees: Membership (1940–44, 1952–54); Constitution and By-Laws (1947–51); Sections (1948–50); Professional Group Co-ordinating and Professional Division Advisory (1948–52, chairman 1950–52); Planning and Co-ordination (1950–52, 1954–56); Board of Directors (1952–54); General Applications Division (1952–54); Student Branches (1953–55); Technical Operations (1955–56); Publication (chairman 1955–56).

J. C. Strasbourger (AM '31, M '40), assistant to purchasing agent, Cleveland (Ohio) Electric Illuminating Company, has been named head of the AIEE Administration Department, one of the five new Departments approved by the Board of Directors. Mr. Strasbourger was born in Cleveland, Ohio, December 22, 1906. He was graduated from the University of Cleveland in 1929 with a degree in electrical engineering, and acquired his bachelor of laws degree in 1934 from the Cleveland Law School. Mr. Strasbourger became associated with the Cleveland Electric Illuminating Company in 1929, and began his work there as an electrical engineer. He has worked in relay testing and field engineering, system operation, and procurement and mechanization. Mr. Strasbourger is a member of the Cleveland Engineering Society and the Engineers Club of New York. He is a former vice-president of AIEE District 2, and has served on the following AIEE Committees: Planning and Co-ordination (1946–49, 1954–56); Sections (1947–50, 1951–55, chairman 1947–49); Committee on Award of Institute Prizes (1948–49); Safety (1950–51); and Sections (1953–54).

W. A. Lewis, Jr. (AM '27, F '45), professor of electric power systems engineering at the Illinois Institute of Technology, Chicago, Ill., has been named head of the AIEE Professional Development and Recognition Department, one of the five new Departments approved by the Board of Directors. Dr. Lewis was born in Harriman, Tenn., January 21, 1904. Attending California Institute of Technology on a Westinghouse scholarship, he received the degrees of bachelor of science in 1926, master of science in 1927, and doctor of philosophy in 1929. Until 1939, he was central station engineer with the Westinghouse Electric Corporation, East Pittsburgh, Pa., and in that year he was appointed director of the school of electrical engineering at Cornell University, Ithaca, N. Y. In 1944, he was named consulting electrical engineer to the Armour Research

J. L. Callahan

W. R. Clark

W. S. Hill

W. A. Lewis

J. C. Strasbourger

Foundation at the Illinois Institute of Technology, and also research professor in the electrical engineering department. Dr. Lewis has served on the following AIEE Committees: Protective Devices (1933–46, 1948–56); Education (1939–40, 1941–42); Basic Sciences (1940–50, 1953–56, chairman 1941–42); Power Transmission and Distribution (1939–43); Standards (1941–42, 1952–56); Research (1941–46, 1952–56, chairman 1943–45); Technical Program (1941–42); Award of Institute Prizes (1943–45); Relays (1947–50); Washington Award (1949–51); Power Division (1952–56); Rotating Machinery (1953–56); Switchgear (1954–56); and Planning and Co-ordination (1954–56).

OBITUARIES

George W. Lautrup (AM '18, Member for Life), engineer, Otis Elevator Company, New York, N. Y., died recently. He was 78 years old. Mr. Lautrup was born in Copenhagen, Denmark, in 1877. He graduated from the University of Mittweida, Saxony, Germany, in 1900 as an electrical engineer. After spending two years in Germany designing typesetting machines, he came to the United States to work for the Winslow Elevator Company, Chicago, Ill. He was then employed by the George P. Nichols Company where he designed railroad turntables and cranes. In 1909, he joined the Otis Elevator Company, remaining there until his retirement in 1947. At Otis, he was concerned with the design of gearless traction machines and d-c motors and generators. During World War II, he helped design a bomb hoist for airplanes, mountings for aerial cameras, and ammunition racks for destroyers.

Thatcher Harold Mawson (M '54), electrical engineer, Southern Services, Inc., Birmingham, Ala., died recently at the age of 52. Mr. Mawson was born in Norfolk, Va. He graduated from William and Mary College in 1925 with a bachelor of science degree, and from the Massachusetts Institute of Technology in 1927 with a master of science degree in electrical engineering. Following his graduation, he was employed by Allied Engineers, Inc., Birmingham, Ala. In 1932, he served with Gibbs and Hill Company as an inspector on the electrification of the Pennsylvania Railroad. In 1933, he was employed by the Swan Chemical Company, Anniston, Ala., where he remained until joining the Commonwealth and Southern Organization, predecessor to Southern Services, Inc., in 1937. Mr. Mawson served on the following AIEE Committees: Protective Devices (1947–56), and Power Generation (1948–49).

Alvin Francis Magowan (AM '53), assistant electrical engineer, Norwalk Division, Connecticut Light and Power Company, died recently. Mr. Magowan was born in Philadelphia, Pa., August 11, 1912. He attended Worcester Polytechnic Institute where he received a bachelor of science degree in electrical engineering in 1934. From 1935 to 1937, he was district representative for the Central Massachusetts Electric Company. In 1938, he became a junior engineer at the J. Stevens Arms Company. From 1940 to 1945, he served as foreman, production inspection department, Hamilton Standard Propellor Division, United Aircraft Corporation, East Hartford, Conn. In 1945, he joined the Connecticut Light and Power Company as an engineering assistant, being made assistant engineer in 1952.

Walter C. Heston (M '45), engineering editor of *Electrical West*, a McGraw-Hill publication, died recently at the age of 63. Mr. Heston's long and valuable career in the western electric utility industry began with his employment by the Portland Railway Light and Power Company, a predecessor of Portland General Electric Company. In 1922, he became Pacific Coast editor of *Electrical World*, a position he held until 1932. After leaving *Electrical World*, Mr. Heston worked with electrical contractors on projects such as the transmission line from Hoover Dam to the Metropolitan Water District. He then served as engineer for power companies at Boulder Creek and Crescent City, Calif. In 1939, he joined the lighting staff of Pacific Gas and Electric Company in San Francisco, Calif. Later he became industrial engineer for the Northern California Electrical Bureau to participate in a wiring modernization program. After this service, he was an electrical engineer at Marinship in Sausalito, Calif., and also taught electrical apprentices at Samuel Gompers Trade School. After the beginning of World War II, Mr. Heston joined the staff of *Electrical West* in 1943 as engineering editor, the position he held at the time of his death. He was a member of the Pacific Coast Electrical Association, Electric Club of San Francisco, and the Engineers Club of San Francisco.

MEMBERSHIP

Recommended for Transfer

The Board of Examiners at its meeting of July 19, 1956, recommended the following applications for transfer. Any objections to these transfers should be filed at once with the secretary of the Institute. A statement of valid reasons for such objections must be furnished and will be treated as confidential.

To Grade of Member

Allen, B. F., engineer, General Electric Co., Rome, Ga.
Andreae, F. V., chief engineer, southern ferro alloys div., Tennessee Products & Chemical Corp., Chattanooga, Tenn.
Bateman, A. W., senior advance engineer, General Electric Co., Philadelphia, Pa.
Bird, R. E., senior group engineer, Boeing Airplane Co., Renton, Wash.
Burnett, J. R., associate professor of electrical engineering Purdue University, Lafayette, Ind.
Chabot, F. E., advance engineer, General Electric Co., Philadelphia, Pa.
Chu, Y., supervisor engineer, air arm div., Westinghouse Electric Corp., Baltimore, Md.
Daniels, H. R., senior hydro engineer, Pacific Gas & Electric Co., Sacramento, Calif.
Fenton, L. T., supervising engineer, Commonwealth Edison Co., Chicago, Ill.
Fisher, W. H., chief electrical engineer, The California Oregon Power Co., Medford, Ore.
Freienmuth, W. L., project engineer, Vitro Laboratories, Silver Spring, Md.
Fuller, W. F., senior design engineer, Texas Electric Service Co., Fort Worth, Tex.
Gajewski, W. M., senior engineer, atomic power div., Westinghouse Electric Corp., Pittsburgh, Pa.
Gold, J., electrical engineer, electro dynamics div., General Dynamics Corp., Bayonne, N. J.
Gray, E. T., relay & communications engineer, Westinghouse Electric Corp., St. Louis, Mo.
Herbert, C. V., electrical engineer, The Celotex Corp., Hamlin, Tex.
Herzog, G. W., design engineer, Canadian Genera Electric Co., Peterborough, Ont., Can.
Hollander, G. L., section head, Clevite Research Center, Cleveland, Ohio
Hoover, R. M., assistant professor, Pennsylvania State University, University Park, Pa.
Horton, L. S., electrical engineer, California Oregon Power Co., Medford, Ore.
Howell, J. K., regional engineering supervisor, Westinghouse Electric Corp., St. Louis, Mo.
Ketchum, J. R., senior research engineer, aero div., Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.
Kirkwood, T. C., partner, A. C. Kirkwood & Associates, Kansas City, Mo.
Law, G. G., electrical engineer, Sargent & Lundy, Engineers, Chicago, Ill.
Martin, T. J., district service manager, Westinghouse Electric Corp., St. Louis, Mo.
Miller, H. N., branch manager, Westinghouse Electric Corp., Portland, Ore.
Nelson, P. C., design engineer, Westinghouse Electric Corp., East Pittsburgh, Pa.
Pugsley, D. W., manager, products engg., General Electric Co., Syracuse, N. Y.
Rice, S. C., electrical engineer, U. S. Bureau of Reclamation, Sacramento, Calif.
Rinker, L. E., electrical engineer, Leupold & Stevens, Portland, Ore.
Sandberg, C. E., underground distribution engineer, Ohio Edison Co., Akron, Ohio
Scheer, A., chief electrical engineer, Shaw Metz & Dolio, Chicago, Ill.
Shoemaker, D. K., application engineer, General Electric Co., Allentown, Pa.
Smith, N. E., supervisor, Philadelphia Electric Co., Philadelphia, Pa.
Stiles, J. W., operations engineer, Ontario Hydro Electric Commission, London, Ont., Can.
Stokes, C. A., electrical engineer, Western Maryland Railway Co., Baltimore, Md.
Thiesfeld, H. W., field engineer, Rural Electrification Administration, Mankato, Minn.
Thomas, C. H., engineer, General Electric Co., Schenectady, N. Y.
Thurell, J. R., Jr., engineer, General Electric Co., West Lynn, Mass.
Trouant, V. E., chief product engineer, Radio Corporation of America, Camden, N. J.
Tucker, J. A., asst. to department head, Massachusetts Institute of Technology, Cambridge, Mass.
Weslowski, A. J., design engineer, General Electric Co., Erie, Pa.
Willson, K. R., senior electrical engineer, light dept., city of Seattle, Wash.
Wittenberg, H., assistant chief engineer, Control Corportion, Minneapolis, Minn.

44 to grade of Member

Applications for Election

Applications for admission or re-election to Institute membership in the grade of Member, have been received from the following candidates, and any member objecting to election should so notify the Secretary before September 25, 1956 or November 25, 1956, if the applicant resides outside of the United States, Canada or Mexico.

To the Grade of Member

Auterson, G., Lloyds's Register of Shipping, London, England
Barnes, C. C., Central Electricity Authority, London, England
Blain, G. E., Stickle & Associates, Architects & Engineers, Cleveland, Ohio
Dent, W. U., Westinghouse Electric Corp., San Francisco, Calif.
Eldridge, F. B., U. S. Signal Corps Engineering Laboratories, Fort Monmouth, N. J.
Gillespie, D. C., The Mountain States Tel. & Tel. Co., Helena, Mont.
Julie, L., Julie Research Laboratories, Inc., New York, N. Y.
Lang, G. J., Elcalor Ltd., Aarau, Switzerland
Lar Rieu, E. A., Jr., The Pacific Tel. & Tel. Co., San Francisco, Calif.
Leesmann, W. B., Jr., Sperry Gyroscope Co., Garden City Park, L. I., N. Y.
Luxton, W. C., General Electric Co., New Haven, Conn.
Mitchell, H. F., Jr., Univac Div., Remington Rand, Los Angeles, Calif.
Morgan, F. D., Commonwealth Associates Inc., Jackson, Mich.
Munoz A., J., Fabricato, Medellin, Colombia, S. A.
Pollard, E. A., Federal Wire & Cable Co., Ltd., Guelph, Ont., Can.
Rogers, J. V., The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C., Can.
Sherrick, D. C., Kleinschmidt Laboratories Inc., Deerfield, Ill.
Stiles, A. P., American Bosch Arma Corp., Garden City, N. Y.
Swaney, B. H., General Electric Co., Erie, Pa.
Tiley, G. L., Canadian Westinghouse Co., Hamilton, Ont., Can.
Todd, K. P., Mountain States Tel. & Tel. Co., Helena, Mont.
Willis, P. T., Chas. B. Farrow, 550 - 9th St., San Francisco, Calif.

22 to grade of Member

IN EDUCATIONAL CIRCLES

ACTIVITIES AND INTERESTS

Special Student Activities Held During Summer and Pacific Meeting

A PROGRAM of special activities for students was arranged by the Committee on Students in connection with the AIEE Summer and Pacific General Meeting, San Francisco, Calif., June 25–29, 1956.

Included in the student program were an inspection trip to the Radiation Laboratory of the University of California at Berkeley, June 26, and a tour of the Pittsburgh Steam Electric Plant of the Pacific Gas and Electric Company, June 29.

The District 8 Undergraduate Student's Prize Paper Contest was held June 26 at the University of California, Berkeley. The following four papers were presented: "Analog Computation," E. L. Pugh, University of Sant Clara; "A Three Phase Oscilloscope for Symmetrical Component Analysis," R. E. Snowman, California State Polytechnic College; "Predicting the Output of a Second Harmonic Magnetic Amplifier," H. N. Shaver and C. L. Foiles, University of Arizona; and "A Pulse Generator Using Nonlinear Magnetic Cores," W. B. Bridges, University of California.

Joe Vivian, Southern California Edison Company, Prof. L. N. Stone, Oregon State College, and a third Institute member acted as judges. On Wednesday, June 27, the judges came to a unanimous decision that W. B. Bridges be declared the winner. The attendance at the meeting was about 40.

The Counselors and Students Dinner, Tuesday evening, June 26, International House, University of California, Berkeley campus, also was very successful. Prof. F. D. Robbins, chairman District 9 Committee on Student Branches, did an excellent job as master of ceremonies. Speeches were presented by Bradley Cozzens, vice-president District 8, and W. B. Morton, chairman, Committee on Student Branches. Informal talks were given by M. S. Coover, president-elect; N. S. Hibshman, secretary; and M. M. Ewell, vice-president-elect, District 9. Dinner was served to 45, and a few corporate members arrived for the talks following the dinner. After adjournment, the counselors and students from District 8 and 9 met at the opposite ends of the room and held their district business meetings.

On Thursday, June 28, C. F. Dalziel, chairman, Committee on Students, Summer and Pacific General Meeting, introduced at the convention noon luncheon held at the Fairmont Hotel, the first-prize winners from the various district student paper competitions. All of the first-prize paper winners were present. They were: North Eastern District, R. E. Jacobson, University of Massachusetts; Middle Eastern District, A. J. Pennington, Princeton University; New York City District, C.A. Von Urff, New York University; Southern District, C. O. Alford, Georgia Institute of Technology; Great Lakes District, R. Dolak, Iowa State College; North Central District, G. D. Green and L. M. Hill, University of Colorado; South West District, W. F. Osborn, Texas A and M; Pacific District, W. B. Bridges, University of California; North West District, Allen Blankenship, University of Washington; and East Central District, R. Colglazer, Jr., University of Cincinnati.

G. W. Dunlap Completes Year as Visiting Professor at MIT

AN ENGINEERING EXECUTIVE in one of industry's largest laboratories who went back to college for a year has stated that the modern engineering graduates "can almost write his own ticket."

Dr. G. W. Dunlap (F '48), a General Electric Company nuclear expert who has recently completed a year as Visiting Webster Professor of electrical engineering at Massachusetts Institute of Technology (MIT), Cambridge, Mass., declared that the technical world which today's engineering graduate enters is the most exciting, the most challenging, and the most rewarding in history—and is becoming more so.

TWO SOPHOMORES at Massachusetts Institute of Technology (MIT) benefit from the academic and industrial experience of Dr. G. W. Dunlap of Schenectady, N. Y. (*left*), General Electric Company engineering executive, in a college laboratory problem. Dr. Dunlap, a leading nuclear physicist, has just completed a one-year leave from the company to serve as Visiting Webster Professor of electrical engineering at MIT.

Courtesy General Electric Co.

With the demand for technically trained men far exceeding the supply, he believes that the educational and job opportunities are so great that a boy cannot afford not to go to college.

If every technical-minded boy could see the scope of interesting problems confronting industry and the breadth of new knowledge available in the colleges, he could not help but be impressed with the opportunities for a satisfying career as a scientist or an engineer.

In addition to teaching, Dr. Dunlap served as a research consultant and as an adviser to graduate and undergraduate students. Referring to this experience, he made the following statements.

Because of the enormous inventory of technology, change is certain. Hence, the university must hammer home the need to think and to be creative in basic engineering principles rather than in mere facts and practices.

Industry for its part must use this new talent effectively. It must encourage the young man's creativity rather than stifle it in "handbook" chores and laboratory routine. There is a need for people who are educated and have creative ideas, not just people who are well informed.

Dr. Dunlap said that a great deal depends on the student himself from grade school to graduate school. He had this counsel for future engineers:

The student must accept the importance of a thorough grounding in mathematics, physics, and the sciences.

ELK County Scholarship Winner

THE VOCATIONAL GUIDANCE COMMITTEE of the Ridgeway, Pa., Section of AIEE gathered recently to congratulate the winner of the 1956 Elk County Engineering Scholarship. Members of the Committee with the winner are (*left to right*) Leo Simbeck, Committee chairman; C. E. Sassman, Ridgeway Section chairman; W. P. VanVranken, Committee member; S. A. Mortimer, scholarship winner; J. H. Schneider, Committee member; C. F. McGinnis, Committee member; and R. F. Edwards, Committee member. Mr. Mortimer, a 1956 graduate of Johnsonburg High School, Johnsonburg, Pa., has enrolled at the Pennsylvania State University, electing industrial engineering as his course of study. The Elk County Scholarship, $1,200 for the 4-year period, was awarded this year for the fourth time by the Ridgeway Section.

He must realize that the more education he gets, the further he will progress, and the more bountiful his rewards will be.

Consequently, in terms of the long pull, it would be extremely foolish for a student to let temporary financial obstacles or the lure of an immediate paying job discourage him from an engineering or scientific career.

Both Dr. Dunlap and the head of MIT's electrical engineering department, Prof. G. S. Brown, urged a closer liaison between industry and education.

Professor Brown added that industry must know what is being done on the campuses. By having Dr. Dunlap at MIT for a full academic year, it was possible to get the continuous counsel of a scholar who himself is concerned with the future requirements of his company and our program.

Dr. Dunlap is the third prominent engineer to hold the Edwin Sibley Webster Professorship since it was established by a $400,000 grant in memory of the co-founder of Stone and Webster, Inc.

He is a member of the New York State Society of Professional Engineers, the American Physical Society, and the American Nuclear Society. A native of Gardnerville, Nev., he was graduated from Stanford University and received his doctor's degree in electrical engineering there in 1935. He joined General Electric that same year, and has served continuously in the General Engineering Laboratory. He was named manager of the engineering physics and analysis laboratory in 1953.

AEC To Sponsor Training Conference for U. S. Educators

L. L. Strauss, chairman, announced recently that the Atomic Energy Commission (AEC) will sponsor a conference on engineering education and nuclear energy for college and university presidents and deans of engineering, at Gatlinburg, Tenn., September 5–8, 1956. Presidents and deans of engineering of 150 colleges and universities having accredited engineering courses have been invited. Dr. W. F. Libby, member of the Commission, will address the conference at a dinner meeting September 6.

The purpose of the conference, which was suggested by the American Society for Engineering Education, is to provide an opportunity for college and university administrators to discuss programs of education and training for science and engineering students planning nuclear energy careers. The program will include presentations and discussions of recent developments in engineering education in nuclear energy, of anticipated needs for personnel trained in this field, and of the Commission's educational and training program in nuclear energy technology.

Conference speakers will include members of the staffs of the AEC and its National Laboratories, and representatives of private industry and educational institutions.

The program includes a tour on September 7 of the Oak Ridge Institute of Nuclear Studies at Oak Ridge, Tenn., and the unclassified facilities of the Oak Ridge National Laboratory.

Arrangements for the conference are being made by the AEC, through the Oak Ridge National Laboratory and the Oak Ridge Institute of Nuclear Studies.

Petroleum Distribution Program To Start at WMC

Petroleum Distribution, a new two-year program to equip men for work in the varied phases of the petroleum industry, has been approved at Western Michigan College (WMC), Kalamazoo, Mich., and will be inaugurated in the Fall.

Based upon an alternate co-operative scheme, students will be paired. While one is in the classroom, the other will be gaining practical experience in some phase of petroleum distribution in a job assignment. Periodically they will exchange so that each receives needed experiences to fulfill the intent of the program.

Planned under the school of Applied Arts and Sciences, the newest educational venture on the Kalamazoo campus came about because of intense interest displayed by petroleum processors, dealers, and retailers, both within Michigan and throughout the United States. The only similar program is now conducted in the New York City Community College.

Officers of the College-Industry Advisory Committee are Ralph Townsend, Pure Oil Company, chairman; S. K. Makemson, John Wood Company, vice-chairman; and Adrian Trimpe, WMC, secretary.

Members of the Committee are D. A. Birkes, Ethyl Corporation; Reed Brazelle and L. R. Kamperman, Leonard Refineries; Martin Citrin, Citrin Oil Company; Dr. Fred Dow, Dow Chemical Company; Truman Gish, Naph-Sol Refining Company; Joseph Hadley, Michigan Petroleum Association; Cash Hawley, National Congress of Petroleum Dealers; Lee Jonhson, Oakley and Oldfield; T. J. Sewiek, Socony-Mobil Oil Company; Russell Spooner, Standard Oil Company; D. T. Thompson, Speedway Petroleum Corporation; Harold Waggoner, Waggoner Transportation Company; and G. H. Young, Ohio Oil Company.

Representing the college are President P. V. Sangren, Vice-President R. H. Seibert, Dean G. E. Kohrman, Leonard Gernant and W. B. Fidler.

Persons entering this two-year program will receive some technical training, science, basic studies, and their co-operative work experience. Among special courses planned for them are petroleum chemistry, introduction to petroleum industry, petroleum technology, motor transport operation and performance, application of petroleum products, and service station operation.

On the business sides are psychological aspects of business, economic marketing, and transportation, business law, salesmanship, small business management, credit and collection, and accounting.

WCEMA Engineering Scholarships Go to 18 Schools

The West Coast Electronic Manufacturers Association (WCEMA) has given 18 Western universities major scholarship grants for deserving engineering students, according to T. P. Walker, president of the organization. The donations will permit as many as 30 students to attend engineering schools during the 1956–57 term.

Funds for the WCEMA scholarship program come from donations by companies which are members of the association. These companies are situated in the three West

Coast states, and many donate sums equal to a dollar for each of their employees to make up their contributions to the association-sponsored program.

Heading the scholarship program for WCEMA during 1956 were J. M. Loge of Los Angeles, Calif., and St. George Lafitte of San Carlos, Calif. Both are executives of WCEMA member firms.

The schools receiving scholarship grants for the 1956–57 school term are: University of Arizona, University of British Columbia, University of California at Berkeley, University of California at Los Angeles, California Institute of Technology, California State Polytechnic College, University of Idaho, Loyola University of Los Angeles, Oregon State College, San Diego State College, University of San Francisco, San Jose State College, University of Santa Clara, University of Southern California, Stanford University, University of Utah, Utah State Agricultural College, and University of Washington.

The dean of engineering in each school selects the students to receive the awards, which are given to freshmen and sophomores, or juniors entering from junior colleges.

Spokane Section Honors Professors

SPECIAL HONORS were conferred upon five professors during the Spokane Section's annual get-together with the student branches at the University of Idaho (U of I) and State College of Washington (WSC). The meeting was held at Pullman, Wash., on May 18, 1956. Each of the men honored was presented with a framed citation from the Spokane Section "... in appreciation of his years of service to the engineering profession and in recognition of his achievements as an outstanding educator in the field of electrical engineering." Among those present at the meeting were (*left to right*) R. F. Knox, student branch counselor, WSC; Prof. O. E. Osburn, WSC; Prof. J. H. Johnson, U of I; Prof. H. F. Lickey, WSC; Prof. H. J. Dana, WSC; Dean R. D. Sloan, WSC; and N. H. Meyers, Spokane Section chairman.

AMF To Supply German University with Research Reactor

A contract has been signed at the German Consulate by AMF Atomics Inc., subsidiary of American Machine and Foundry Company, and the Federal Republic of Germany's State of Bavaria calling for the construction by AMF of a research reactor at Munich's Technische Hochschule for the training of atomic scientists.

Unprecedented in free Europe, it will be the first reactor to be installed at a university for training engineering students in nuclear science.

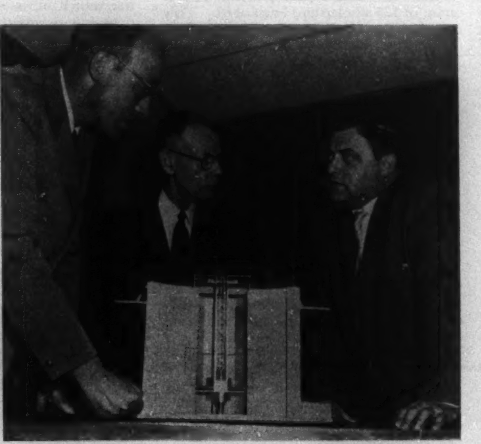
As approved for the German government by F. J. Strauss, the Federal Republic of Germany's minister for Atomic Energy, the contract was signed at the German Consulate by Gen. W. B. Smith, president and board chairman of AMF Atomics Inc., and Prof. H. Maier-Leibnitz, director of the Laboratory for Technical Physics at Munich's Technical University (Laboratorium fue Technische Physik der Technischen Hochschule Muenchen), for which the reactor will become a tool. Prof. Maier-Leibnitz acted on behalf of the State of Bavaria which is purchasing the reactor.

Technische Hochschule Muenchen is one of Germany's leading advanced technological institutes. The reactor will be the heart of a new nuclear research center at the University which will permit broad expansion of nuclear science studies already being conducted there under Prof. Maier-Leibnitz's direction.

Gen. Smith stated that the installation of the reactor and the development of the nuclear research center which it will serve will be a most significant milestone in free Europe's peaceful atom program. The specialized training the reactor will make possible will create a new supply of nuclear scientists which German industries will have access to in implementing their own nuclear research program.

Prof. Maier-Leibnitz said construction of the one megawatt "swimming pool" type reactor is scheduled to start in October, with July 1957 as the "start-up" operation date.

Nuclear fuel for the reactor will be supplied by the United States Government according to the bilateral agreement it has with the government of the Federal Republic of Germany to make the U-235 available in furtherance of the peaceful atom program.



INSPECTING a scale model of the first nuclear research reactor to be installed in a university in free Europe for the training of engineering students in nuclear science are (*left to right*) Prof. H. Maier-Leibnitz, director of the Laboratory for Technical Physics at Munich's Technical University where the reactor will be installed; Gen. W B. Smith, president and chairman of the board of AMF Atomics Inc., constructors of the reactor; and F. J. Strauss, the Federal Republic of Germany's minister for Atomic Energy.

Lear Foundation Provides Scholarship Grant

An engineering scholarship grant has been made available to the University of Michigan by the William P. Lear Foundation, Inc.

Ultimate disposition of the fund will be in the hands of the school's Scholarship Committee.

The William P. Lear Foundation has suggested only that the award be used to further the education of a needy but deserving student majoring in aeronautical engineering or specializing in electronics as applied to the aircraft industry.

AEC Approves Loan of Uranium Metal to Two Schools

Two loans totalling 8,000 pounds of natural uranium metal, plus neutron sources, to be used in connection with expanding instruction in nuclear engineering, have been approved for the University of Florida, Gainesville, Fla., and the Virginia Polytechnic Institute, Blacksburg, Va., by the Atomic Energy Commission (AEC).

The Florida loan is 5,500 pounds and the Virginia loan 2,500 pounds. The metal, in the form of 8-inch rods enclosed in aluminum, will be used in subcritical assemblies in which nuclear fission can be produced but which do not sustain a chain reaction.

The facilities require no unusual safety controls, expensive shielding, or heat removal equipment and may be used for many laboratory exercises in nuclear engineering training.

The subcritical assembly consists of an arrangement of the uranium rods in a moderator such as graphite or ordinary water. When a neutron source is introduced, a neutron flux can be obtained from nuclear fissions in the arrangement but the reaction cannot be sustained without the presence of the neutron source.

Under a recent amendment to the Commission assistance policy, neutron sources composed of plutonium and beryllium now are available for licensing to the users of subcritical assemblies. This type of source is considered superior in many ways to those previously available.

The Commission for some time has been supplying certain materials for these assemblies without a use charge being made, subject to the availability of the material and to a determination that such loans will result in a net advantage to the Commission's program to assist in alleviating the current shortage of nuclear scientists and engineers.

Minnesota Firms Provide Nuclear Research Facility at UM

A gamma ray facility for research in engineering, medicine, biology, and agriculture will be constructed at the University of Minnesota with the aid of a $65,000 grant from 23 business and industrial firms banded together in the "Minnesota Nuclear Operations Group."

The Group was organized last year by Northern States Power Company, Minneapolis-Honeywell Regulator Company, and General Mills, Inc., to study developments in the atomic energy field with a view to benefiting Minnesota resources and industry.

Membership in the group was increased this year to include 20 other Minnesota firms, including banks, insurance companies, and industrial corporations.

The gamma ray facility to be built on the University of Minnesota campus will be operated by the Institute of Technology. It will be used in research on the application of nuclear irradiation in such fields as solid-state physics, materials, radio chemistry, medicine, biology, and food preservation and agriculture.

Dean Athelstan Spilhaus of the Institute of Technology said that the facility would be a most important tool, not only to permit the carrying out of experiments in many fields, but also in the training of engineers and others in the University in various phases of nuclear technology.

He continued by saying that these people will be most important to all industries in the state as their participation in the peaceful applications of atomic energy grows.

Two Engineers Awarded Lamme Scholarships

Two Westinghouse Electric Corporation engineers have been awarded graduate scholarships for a year of advanced study.

C. J. Baldwin, Jr. (AM '52) and R. O. Decker, both of Pittsburgh, Pa., have been named for the Benjamin Garver Lamme graduate scholarships valued at about $2,500 each. Both will begin their advanced studies at Massachusetts Institute of Technology (MIT) this fall.

The Lamme Graduate Scholarship Fund was established by Westinghouse in 1927 as a memorial to the company's former chief engineer.

Three Scholarships Granted to Lehigh University

Lehigh University, Bethlehem, Pa., has been granted three undergraduate scholarships by the Western Electric Company, E. W. Glick, university treasurer, has announced. The grants are included in the company's expanded aid to higher education.

Each of the three scholarships, two in engineering and one for liberal arts or business administration, will be valued at $800. In addition, the company has announced $1,800 to Lehigh as a grant-in-aid. The company is supplementing each scholarship award in privately controlled institutions since the actual cost of education exceeds the amount charged the student for tuition.

Four other Pennsylvania institutions are to share in Western Electric's national program of 125 scholarships established. They are Lafayette College, Pennsylvania State University, Bucknell University, and the University of Pennsylvania.

Selection of recipients will be made by the institutions. At Lehigh University, the grants will be awarded to students starting September 1956 according to Dr. W. H. Congdon, chairman of the committee on scholarships and loans.

Grants at Lehigh will be made on the basis of high academic standing in the fields of study related to the company's operation, financial need, character and personality, and scoring in College Board tests.

In announcing the company's program of approximately $250,000, Western Electric President F. R. Kappel stated that the adoption of this program constitutes recognition of the company's continuing interest in higher education. As an industry relying heavily on the abilities of college trained people, the company is glad to work with members of the industrial community by helping the institutions of higher learning keep their standards high and their doors open to able young men and women.

More Women Engineers Is One Answer to Current Shortage

Dr. C. B. Jolliffe, vice-president and technical director of the Radio Corporation of America (RCA), urges greater use of women in engineering and the physical sciences as one means of easing the critical shortage in those fields.

Speaking at a dinner in honor of the President's Committee for the Development of Scientists and Engineers, Dr. Jolliffe said that women could be useful as graduate engineers and scientists, and as laboratory technicians.

He stated that RCA has been actively recruiting in the women's colleges as well as in coeducational schools, but the number of women graduates trained in electronics has been relatively small.

Dr. Jolliffe believes it is necessary to go back to the high schools and stimulate the interest of girls in the basic subjects like mathematics and physics, and the other sciences, and to convince them that there are careers in science which are available to women.

The National Committee, which is headed by Dr. H. L. Bevis, president of Ohio State University, was appointed by President Eisenhower to examine the shortage of scientists and engineers and recommend possible solutions. Committee members were guests at a dinner of the Thomas Alva Edison Foundation in Newark, N. J.

Dr. Jolliffe further suggested that in considering solutions for the shortage, the Committee should explore three broad areas: improvements in long-range compensation, improvements in utilization of engineers and scientists, and improvements in education. He said that engineers who graduated 20 or 30 years ago often find themselves with incomes that are much less than those in other professions, or in many nonprofessional activities.

He stated that engineers and scientists must be used on the high-level professional assignments for which they are trained, and not wasted on marginal tasks that can be done just as well by others. This can be accomplished by more extensive use of laboratory technicians—men and women capable of handling those jobs which are essential to the progress of scientific research but which do not involve advanced technical knowledge.

He urged the Committee to give prompt consideration to a plan for a National Education Reserve, proposed earlier this year by Brig. Gen. David Sarnoff, chairman of the Board of RCA. Under this plan, industrial concerns would release for at least one year, with full pay, a reasonable number of qualified engineers and scientists in order that they could teach in their local high schools.

The electronics industry, which employs about 50,000 scientists and engineers, could use between 8,000 and 12,000 more if they were available with the right specialties, Dr. Jolliffe said. As automation expands, thousands more electronic engineers and scientists will be needed for designing and constructing the machinery and for installation and maintenance.

OF CURRENT INTEREST

DR. H. R. DAY, scientist at the General Electric Research Laboratory holds a thin information storage mesh above the "reading and writing" tube in which it operates. The tiny honeycomb is electronically magnified on the television screen in the background. This new information storage tube is expected to have wide use in smaller computers with bigger memories.

"Honeycomb" Memory Stores 800,000 Bits in Inch-Square

AN INCH-SQUARE "honeycomb" developed by a General Electric scientist will store up nearly a million bits of information. Smaller electronic computers with bigger memories are among the anticipated applications.

Dr. H. R. Day of the General Electric Research Laboratory describes his new information storage tube as a thin sheet of glass in which small holes have been etched and then filled with metal at the heart of the tube. In practice, information is written onto one side of the honeycomb by an electron-beam scanning method similar to that used in television. A "reading gun" picks up the information from the opposite side. Early laboratory models have permitted storage for several minutes and Dr. Day is confident the time can be extended.

Inasmuch as the holes in the honeycomb are spaced 500 to the inch, each square inch has 250,000 individual storage cells, and each cell will recognize at least ten different levels of intensity from the writing gun. Logarithmic calculations increase to more than 800,000 the number of bits of information that can be stored at one time ($250{,}000 \times \log_2 10$).

Possible applications for the new storage tube in addition to computers include television cameras and "scan converters" in which radar information is collected and then displayed on an ordinary television screen.

The "mosaic" principle has long been recognized as ideal for storage tubes, but Dr. Day's device is believed to be the first developed with sufficient resolution and ruggedness to be suitable for most applications.

SIGNAL STORAGE TUBE

SCHEMATIC DRAWING of information storage tube using new high-resolution memory cell developed at the General Electric Research Laboratory. Inset at lower right shows greatly enlarged view of the glass mesh and its recessed metal plugs. Plugs are only 1/500th of an inch apart, and nearly a million bits of information can be stored on one square inch.

Dr. Day also has solved the problems of "leaking" and "smearing" frequently encountered when individual storage cells are placed so close together. Each storage cell "remembers" by building up charge in the capacitance formed between the recessed metals plugs and the conducting layers deposited on both surfaces of the glass. The glass honeycomb itself acts as an insulator between the plugs and the surfaces layers—and between the plugs themselves.

Another advantage of this system is that the problem of registration is eliminated because the surface layers and the recessed metals plugs are inherently "lined up." Because the spacing between elements is rigidly maintained, the entire structure is very rugged and the usual problem of microphonics (electronic noise caused by mechanical vibration) does not arise.

Two methods of reading the information are available. In one method the electron beam erases the screen as it picks off the stored information; in the other the information can be left for re-reading or to be altered or added to by the writing beam.

Development of Versatile Voltage-Tunable Magnetron Announced

NEW VERSATILITY for the magnetron, famous for its use in wartime radar, has been achieved by two scientists at the General Electric Research Laboratory. Discovery of magnetron "voltage-tuning" has extended the use of magnetrons in new types of microwave relay systems, counter measures, altimeters for aircraft, electronic test equipment, and telemetering operations in which several far-flung metering stations are monitored from a central office.

Along with the unique tuning method have come important new concepts in tube design that make it possible to house this magnetron in a copper and ceramic package no larger than a cube of sugar.

P. H. Peters and D. A. Wilbur first conceived the principle for voltage-tunable magnetrons in the late 1940's. In spite of the successful use of magnetrons during World War II in radar and counter-radar devices, at that time magnetrons still suffered from the inability to be tuned over a relatively wide frequency range except by slow and cumbersome mechanical methods. Voltage tuning makes it possible to vary the frequency over a two-to-one range, and to do it virtually instantaneously.

General Electric's power tube department is preparing for production on the first types in a series of voltage-tunable magnetrons covering the ultra-high-frequency region. It expects eventually to produce tubes operating in the super-high-frequency region.

Progress in voltage tuning has come in several successive steps over recent years. In earlier voltage-tunable magnetrons, limitations of space charge was accomplished by the careful regulation of the temperature of the electron-emitting cathode in the tube. Now General Electric scientists have devised a new type of grid control and electron injection method for their "crossed-field beam control system using a space-charge limited emitting source."

The result is much greater stability, since the tube operation does not fluctuate with heater power supply variations. It also means longer life because the vulnerable cathode is protected.

The new voltage-tunable magnetron looks like a stack of four copper pennies separated by ceramic disks, the entire tube being less than one-half inch high. In construction it is a step-brother of General Electric's new metal and ceramic microminiature tubes which are for the field of ultra-high-frequency electronics.

Peters and Wilbur have likened the operation of the tiny magnetron to that of an a-c generator with a very fluid "rotor" made up of electric space charges. This "rotor" must rotate at speeds up to 60 billion revolutions per minute in order to generate the high frequencies at which the tube operates.

Research on the voltage-tunable magnetron has been conducted by General Electric under sponsorship of the U. S. Army Signal Corps.

The original magnetron principle was discovered at the General Electric Research Laboratory in 1920 by Dr. A. W. Hull. The former associate director of the laboratory has said of the recent work: "The discovery and practical development of the voltage-tunable magnetron is the culmination of many years of fundamental study of the magnetron by Peters and Wilbur. It is but one of several new applications that this study is yielding."

The voltage-tunable magnetron has important and unique characteristics. The frequency varies with anode voltage. This voltage-tuning is virtually instantaneous, it is linear, and it can be performed over a very wide band. Thus, the tube can serve as either a tunable c-w or an FM source. In addition, a control electrode permits amplitude modulation and makes pulse modulation feasible. In the novel cathode design, the emitter is placed outside the r-f section of the tube. This reduces the detrimental effect of back bombardment present in conventional magnetrons and promotes longer life and greater reliability. Countermeasures, altimeters, FM communications, and test equipment are among the many applications for this important new type of tube.

Utility Men and Electrical Distributors Meet

Over 40 men attended a Distributor-Utility 3-day conference at Holophane Engineering Center HEC, Newark, O., recently.

C. Franck, (HEC) president, greeted visitors. Opening day was devoted to subjects of interest to electrical distributors. Distributor co-operation, sales markets and aids were discussed and a control of light demonstration was given. Second, an inspection trip through the Center and factory was followed by a comprehensive display of illuminating engineering principles. The final meeting was a utilities engineering forum which covered study of light sources and their application as well as an extensive demonstration of all types of HEC lighting equipment.

VOLTAGE-TUNABLE MAGNETRON is brainchild of D. A. Wilbur (*left*) and P. H. Peters. The tiny tube itself, made of metal and ceramic disks, is shown in Peters' left hand.

METAL AND CERAMIC DISKS make up both the cutaway version and the complete laboratory version of the approximately $^1/_2$-inch-high voltage-tunable magnetron here shown magnified.

Atomic Products Plant Starts Manufacturing Operations

WHAT WAS ONCE a quiet farming tract 6 miles east of Lynchburg, Va., became an atomic-age landmark recently as The Babcock and Wilcox (B&W) Company Nuclear Facilities Plant began production on the site. The plant is the first major facility erected entirely at private expense to manufacture and test nuclear fuel elements and related products for peacetime use.

The new plant is divided into two spheres of activity—a nuclear fuel element fabrication unit and an experimental unit where reactor core parts will be studied and tested.

The fabrication building has complete metal casting, rolling, welding, and machining equipment to turn out flat-plate type fuel elements. Production already has been begun on a year's supply of fuel elements for the United States Atomic Energy Commission's (AEC) Materials Testing Reactor at Arco, Idaho. Delivery of the first 35 assemblies is scheduled for August.

This manufacturer of steam generation and auxiliary equipment also has contracted to design, fabricate, erect, and test the nation's first privately owned nuclear steam generator for the Consolidated Edison Company (ConEd) of New York. Production of fuel elements for this reactor will begin as soon as final design details have been completed.

Operations

Initial operations in the new plant's experimental facility will be devoted to determining the nuclear characteristics of the ConEd reactor design. The first core assembly, made to one-quarter scale, will be tested at a power level which will seldom exceed the output of an ordinary flashlight battery. Thorium, which is converted to new reactor fuel as fissioning takes place, will be a component of fuel elements employed in tests, representing the first nuclear use of thorium by private industry.

The experimental facility, which is near the fabrication building, will be completed shortly. A reinforced concrete bay nearly three stories high, with walls running to a thickness of 3 feet, forms the test chamber for critical assemblies. Space for offices, shops, a control room, laboratories, a vault, and other units has been built into a low wing.

Although early activities at the plant involve existing contracts, Alfred Iddles, president of the company, pointed out that the entire unit has been designed to manufacture and test a broad range of present and future reactor and fuel element types.

In planning the fabrication plant, provisions were made to add the facilities necessary to make pin, rod, and cylindrical type fuel elements, as well as the flat-plate types.

Welding

Achieving economical welds which are uncontaminated, corrosion-resistant, and nonporous is vital in fuel element fabrication.

Heliarc welding employs a concentration of helium or argon gas in the welding zone to protect it from contamination by atmospheric gases. Welding heat is provided by an electric arc struck between a tungsten electrode and the workpiece. Since no flux or filler rod is required in this process, welds can be made on a variety of joints and metals. Material areas, in heliarc welding, are actually joined by fusion.

Material which has a high melting point and is readily contaminated by crucible components is melted by a process using the material itself as an electrode source.

Melted in an atmosphere of argon-helium mixture, the electrode forms a 4-inch diameter ingot. In turn, this ingot is used as the electrode for the remelt to produce a 6-inch diameter ingot for further processing.

A vacuum arc furnace is employed in the arc melting process. The furnace has an electrode tower which houses the electrode on initial charging. During the remelt operation, the tower is removed. Guide rolls, electric contact rolls, and the electrode drive mechanism are housed in a bell or center section. A speed variator, actuated by power fluctuations during the melting, controls the drive mechanism.

Alloys

For production of certain fuel element alloys, induction melting and casting is employed. The process, which may be conducted in a vacuum, an inert atmosphere, or in air, is centered in an 8-foot by 6-foot by 6-foot furnace.

The furnace has a crucible capacity equivalent to 100 pounds of steel. It is evacuated by an *NRC 100-S* rotary gas ballast mechanical pump, and an *NRC B-6* booster pump. Power is supplied from a motor-generator set rated at 100 kw. Water circulating through copper coils provides cooling for the stainless steel shell.

For vacuum melting, the various materials in the charge are placed in the crucible, inside the induction coil. All ports are closed and sealed with a vacuum grease. The vacuum pumps are then started up, and the complete system evacuated to the desired pressure of approximately 1.0 micron of mercury pressure. The charge is melted by electric power applied in steps to the induction coil.

For melting in an inert gas atmosphere, the charge is placed in the crucible and all furnace ports are sealed. One of the ports is specially designed for insertion of the desired atmosphere. The furnace is then evacuated as desired, the vacuum isolated from the furnace shell, and the system purged to the desired pressure with the specified gas (argon, helium, etc.). Further steps are substantially the same as those used in vacuum melting. For melting in air, the furnace door is closed but not sealed.

Radioactivity Control

Although materials used in making fuel elements are not highly radioactive, special equipment has been built into the plant to prevent, as much as possible, human contact with even the most minute particles of these substances.

Any equipment which may be a potential source of radioactive contamination is

Future Meetings of Other Societies

National Metal Trades Association, September 9–12 Essex-Sussex Hotel, Spring Lake, N. J.

AIChE, National Meeting, September 9–12, Pittsburgh, Pa.

Electron Microscope Society of America, September 9–12, Madison, Wis.

Information Theory Symposium. September 10–12, Massachusetts Institute of Technology, Cambridge, Mass.

Titanium Lecture Program, 2nd Annual Series, Spetember 10–14, New York University College of Engineering, University Heights Campus, The Bronx, N. Y.

ASME, Fall Meeting, September 10–12, Cosmopolitan Hotel, Denver, Colo.

Transport Phenomena in Metals, September 10–14, International Union of Pure and Applied Physics, National Research Council, Ottawa, Ont., Canada.

RETMA, Symposium on Reliability of Electrical Connection, September 11–12, University of Pennsylvania, Philadelphia, Pa.

2nd Conference on Reliable Electrical Connections, RETMA, September 11–12, Irvine Auditorium, University of Pennsylvania, Philadelphia, Pa.

Reaction Mechanisms Conference, September 12–15, Swarthmore College, Swarthmore, Pa.

Conference on Communications, IRE Cedar Rapids Section, September 14–15, Roosevelt Hotel, Cedar Rapids, Iowa.

ASTM, 2nd Pacific Area National Meeting and Apparatus Exhibit, September 16–22, Hotel Statler, Los Angeles, Calif.

Instrument Society of America, Conference and Exhibit, September 17–21, New York, N.Y.

American Transit Association, Annual Meeting, September 17–20, Jefferson Hotel, St. Louis, Mo.

Illuminating Engineering Society, National Technical Conference, September 17–21, Hotel Statler, Boston, Mass.

11th Annual International Instrument-Automation Conference and Exhibit, September 17–21, Coliseum, New York, N. Y.

PGNS-IRE, Annual Meeting, September 20–21, Mellon Institute Auditorium, Pittsburgh, Pa.

National Electrical Contractors Association, Annual Convention and 2nd Exposition, September 23–29, Sheraton-Palace Hotel, San Francisco, Calif.

Atomic Industrial Forum, 1956 Trade Fair, September 24–28, Navy Pier, Chicago, Ill.

Audio Engineering Society, Annual Meeting and New York High-Fidelity Show, September 27–30, New York Trade Show Building, New York, N. Y.

National Electronics Conference and Exhibit, October 1–3, Hotel Sherman, Chicago, Ill.

Heating, Piping, and Air-Conditioning Contractors National Association, The Mechanical Contractors Association of America, Fall Meeting and Conference, October 1–3, Hotel Statler, Detroit, Mich.

American Mining Congress, Metal Mining Industrial Minerals Convention and Exposition, October 1–4, Shrine Exposition Hall, Los Angeles, Calif.

Porcelain Enamel Meeting, ASTM Committee C-22, October 2–3, Battelle Memorial Institute Columbus, Ohio.

Standards Engineers Society, 5th Annual Meeting, October 3–5, Willard Hotel, Washington, D. C.

International Association of Electrical Leagues, 1956 Conference, October 3–6, Sheraton-Cadillac Hotel, Detroit, Mich.

SMPTE, 80th Convention, Exhibits, October 7–12, Ambassador Hotel, Los Angeles, Calif.

International Science and Human Welfare Conference, American Institute of Geonomy and Natural Resources, Inc., October 8, Washington, D. C.

Civil and Military Aeronautical Communications, 2nd Annual Symposium, Rome Air Development Center Griffiss A.F.B., October 8–9, Utica, N. Y.

MODEL of animated pressurized water reactor *AE-9*, which is part of Nuclear Facilities Plant installation.

equipped with a system of microscopically fine filters capable of removing about 99.5 per cent of airborne particles. Should any harmful amounts of gases appear in the Critical Experiment Facility, test activities would be shut down immediately by an exhaust monitoring system.

The effectiveness of control measures and equipment at the plant will be checked constantly by more than 25 different portable and stationary types of instruments, as well as by laboratory analyses. Collection filters located on all exhausting ducts, samples of working area surfaces, liquid wastes, ground surfaces, and the atmosphere in the plant vicinity, will all be monitored daily. Also, periodic surveys will be conducted in plant area communities as a further check on effectiveness of the radiation monitoring system.

At the same time, a broad "health physics" program, in which the science of physics supplements regular health and safety planning, has been instituted to protect employees and area residents.

Employees who work with radioactive materials, or in their presence, are safeguarded by film badges which record an individual's external exposure to radiation. Special film rings are worn to determine exposure to the hands of workers. Those employed in radiation areas carry dosimeters, which record total radiation exposure on a cumulative basis. Protective clothing, including shop coats, hats, safety shoes, shoe covers, aprons, and heat-proof gear, and such devices as safety glasses, face shields, and welding helmets, are also provided.

Much of the equipment used in the plant's health physics program serves as an aid in accounting for the location and disposition of costly nuclear materials handled here. One fuel element component, U-235, runs as high as $11,000 a pound, and materials used in the Consolidated Edison experiment alone will be worth about $7 million. Under a rigid "accountability" system in effect throughout the plant, there is a continuous search for these special materials down to the last one one-hundredth of a gram—an amount smaller than a grain of sand.

Literally scrubbing the air of particles of nuclear materials in the plant's main building is an elaborate circulation and filtration system. The fabrication area, for example, undergoes a dozen complete air changes hourly, with seven circulation units drawing in over 100,000 cubic feet a minute.

Liquid wastes which may contain radioactive or salvageable substances are carefully funneled to central points and monitored. A "tank farm" built on plant property collects liquid wastes for neutralization and disposal.

The accountability program now in operation at B&W's nuclear facilities plant is based on a specialized personnel organization, elaborate instrumentation, and extensive recovery and storage facilities. A central accountability station has been established in the plant. Records showing the movement, location, properties, and disposition of all nuclear materials are directed to this station for the compilation of master records.

For the storage of fissionable materials, vaults have been built with walls of reinforced concrete about one foot thick to withstand shocks of every conceivable type. When a container of fissionable material arrives at the plant, the material is removed, identified, tagged, and weighed. The material is stored on shelves, or in specially designed "bird-cages," so that the density is uniformly several times less than that required for a critical mass.

Equipment in the vault includes counting instruments, delicate balances, and vacuum cleaning devices. Minute particles of fissionable materials can be recovered from the vault floors, which are coated with several layers of hard-finish paint to keep dust at a minimum and to aid in locating grains of fissionable material.

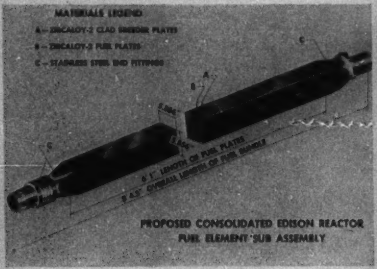
Site Requirements

Erection of the new nuclear facilities plant climaxes a search B&W began in 1954 to find a suitable location. More than 90 evaluation factors—such as weather, communications, soil structure, waste disposal possibilities and even the incidence rate of earthquakes and other disasters—were applied to screen hundreds of possible sites. Thirty-four "finalists" were visited by inspection teams before the Campbell County site was chosen.

B&W has been active in the nuclear field since 1942, when it worked on equipment for the Manhattan Project. For the past 12 years, however, the company has devoted most of its nuclear effort to developing methods for the conversion of atomic energy to usable power.

Fuel Elements

Currently, B&W is producing in its Lynchburg plant a year's supply of fuel ele-


MATERIALS LEGEND
A — ZIRCALOY-2 CLAD BREEDER PLATES
B — ZIRCALOY-2 FUEL PLATES
C — STAINLESS STEEL END FITTINGS
C
A
B
5.886
5.856
C
6' 1" LENGTH OF FUEL PLATES
8' 4.5" OVERALL LENGTH OF FUEL BUNDLE
PROPOSED CONSOLIDATED EDISON REACTOR
FUEL ELEMENT SUB ASSEMBLY

FUEL ELEMENT DESIGN (*above*) proposed for use in nuclear steam generator uses a "sandwich" of source and fertile materials. Induction melting furnace (*right*) used to produce alloys utilized in fuel element fabrication. Workmen are shown completing a melt carried out in air, although equipment is designed for melting in a vacuum or an atmosphere.

ments to be used in the Materials Testing Reactor (MTR) at the National Reactor Testing Station at Arco, Idaho. Under terms of the contract with Phillips Petroleum Company, which is operating the MTR for the AEC, B&W will produce 325 of these fuel elements for immediate delivery. Plates of the MTR elements are an alloy of aluminum and U-235. This plant will also fabricate the fuel elements for the 5,000-kw swimming pool research reactor which B&W will build at Sao Paulo, Brazil.

Two major types of fuel elements are in use today. One is the rod, pin, or slug type, which may vary from 0.30 inch to 2.0 inches in diameter and from 4.0 inches to 10.0 inches in length. An example of this form is the "natural uranium slug" measuring about 1.0 inch by 8.0 inch employed for producing plutonium.

A second type is the strip or plate form. It may vary from 0.01 inch to 0.35 inch in thickness, from 2.0 inches to 5.0 inches in width, and may be 2.0 feet to 15.0 feet long. The MTR fuel element, approximately 0.05-inch thick, 3.0-inches wide and 30.0-inches long, is of the plate type.

Zirconium and enriched uranium metal for fuel plates will be alloyed in the vacuum arc melting furnace. The 100 pound ingot formed will be remelted to improve homogeneity.

The ingot will then be conditioned on a 10-inch lathe to remove imperfect material and sheathed in steel. Next it will be preheated to about 1,450 F for hot forging on the impacter to a billet for rolling. The billet will be reheated and hot rolled on the 2Hi–4Hi rolling mill to approximate fuel element core thickness.

At this point, the steel sheath will be removed and the plate will be cleaned by vapor blasting and acid pickling and cold rolled to punching thickness. Core size pieces will be punched from the plate on the 160-ton press and assembled in a picture frame with zirconium alloy cladding. These assemblies will be sheathed in steel once more, heated in an electric furnace to about 1,450 F, and hot rolled to approximate finished fuel-plate thickness.

Removal of the protective sheath will follow. The element will then be cleaned by vapor blasting and acid pickling and cold rolled to final thickness.

Plates and assembled units will be examined in the laboratory fluoroscope to locate the "meat," and then machined to final width and length and further receive similar treatment.

End nozzles will be attached to the assembly by stainless steel rivets. The assembly then will be moved to the 20-inch engine lathe for final end nozzle machining, after which it will be given an acid cleaning and water rinse and dried. After final inspection, the bundle will be identified on the outside by an engraved code number.

World's Largest Bulldozer Moves Crashed Bombers from Runways

THE LARGEST and most powerful bulldozer-type machine in the world, which was designed for moving any crashed bombers from military airport runways, has been delivered to the United States Air Force by R. G. LeTourneau, Inc., of Longview, Tex., recently.

So powerful is the mammoth mover that a single pair of them can completely remove a 400,000-pound crashed bomber in less than 20 minutes. The same task, using conventional equipment, formerly required from about 5 hours to about 15 hours. Primarily, the bungalow-sized vehicles are designed for use during emergency operations when a disabled aircraft has crash landed and is therefore keeping other planes at the field from taking off or making landings.

Operating in pairs, the 151,000-pound machines place scoops against a crashed plane and literally shovel it off the runway. When thus used for emergencies, the final condition of the crashed plane necessarily is disregarded in order to expedite the use of the facilities at the airport where the accident has occurred.

A powerful, high-torque electric motor is geared directly to each individual wheel making each one an independent drive unit. However, they are designed to work together as a team. If one or more of the wheels lose traction, their portion of the machine's total horsepower is automatically transferred to those other wheels which are taking hold.

Another feature built into this and other LeTourneau equipment is a highly effective regenerative braking system which furnishes operational braking without wearing parts. Mechanical brakes also are included on the machine for parking and any emergency conditions that may arise when the crash equipment is in use.

To steer the rolling giant, an operator merely fingers an electric switch which sends the machine to the left, right, or straight ahead.

In size, the machine is more than 67 feet long, more than 17 feet high, and more than 13 feet wide. It travels on six of the largest tires in the world—each being 10 feet high and 4 feet wide, and each with a ground contact area of almost 1,500 square inches. Although officially it has been labeled the Crash Pusher *CP-1*, Air Force personnel have labeled it the "Fantabulous"—because of the equipment's "fantastic" and "fabulous" aspects.

CRASH PUSHER is here compared to two men walking (*left*) and also to B-36 Bomber (*right*). Behind bomber's nose is second Crash Pusher. Note that each has blade and operator's cab on both ends.

University Lecturing and Advanced Research

The United States Government awards for the 1957–58 academic year for university lecturing and advanced research under the Fulbright and Smith-Mundt Acts in Austria, Belgium and Luxembourg, Chile, Denmark, Finland, France, Germany, Greece, Iraq, Italy, Japan, Netherlands, Norway, and the United Kingdom and Colonial Territories have been announced.

To insure consideration, applications must be postmarked no later than October 1, 1956.

This announcement refers only to the awards offered under the Program for university lecturing and postdoctoral level research.

Ordinarily, awards are made for the full academic year, although in exceptional circumstances applications will be considered for research for periods of not less than six months, or for lecturing for a semester or for the full period of an established summer school.

Awards may be made for only one country and arrangements will be made for those selected to be affiliated with an institution of higher learning abroad.

Awards under the Fulbright Act are made in the currency of the host country. Awards for lecturers and research scholars usually include: (1) round trip transportation for the grantee (provision is not made for the transportation of accompanying dependents); (2) a maintenance allowance which may be adjusted to take into account the expenses of up to four accompanying dependents; and (3) a small supplemental allowance for travel in the host country and books or equipment purchasable abroad.

Maintenance allowances are calculated on the basis of living costs in the host country and therefore differ from country to country in dollar equivalents. In terms of purchasing power, they are approximately equal.

Eligibility requirements are that: (1) applicants must be U.S. citizens; (2) those applying for lectureships are expected to have at least one year of college or university teaching experience in the U. S. or abroad; (3) applicants for research awards are expected to have a doctoral degree from a recognized institution of higher learning in the U. S. or abroad *at the time of application,* or recognized standing in their respective professions. Candidates for the doctoral degree or those expecting to obtain it in the normal course of their training should apply to the Institute of International Education, 1 East 67th Street, New York City; and (4) specialists in such fields as library service, social work, adult education, nursing education, and museum and art gallery methods may apply for either lecturing or research awards and will be considered eligible if they have completed their formal undergraduate and postgraduate training and have been established in their professions for several years.

Other countries where the Fulbright Awards for 1957–58 for the countries in which the academic year begins in the spring or early summer were listed in an announcement issued in March 1956. Closing date for mailing applications under this competition was April 15. The countries included were: Australia, Burma, India, New Zealand, Philippines, and Thailand.

In addition, grants for lecturing abroad under Public Law 402, the Smith-Mundt Act, will be available in approximately 30 countries in Latin America, the Near East and Africa, the Far East, and Europe. Persons interested in opportunities in these countries should communicate with the Conference Board.

Application forms and additional information obtainable from: Conference Board of Associated Research Councils Committee on International Exchange of Persons, 2101 Constitution Ave., Washington 25, D. C.

Nationally Co-ordinated Nuclear Energy Standards Set

Industry took the first big step toward insuring nationally co-ordinated standards in the field of nuclear energy.

Speaking through the Standards Council of the American Standards Association (ASA), industry voted to create a nuclear energy standards board within the ASA to co-ordinate standards.

The Council made up of 70 organizations representing a cross section of industry, acted on a report presented by Morehead Patterson, chairman of the board and president, American Machine and Foundry Company, New York, N.Y., and chairman of the Planning Committee on Standardization in the Field of Nuclear Energy, which was set up at a general industry conference in December 1955.

Mr. Patterson pointed out that there is an urgent need for such a program inasmuch as many state regulatory bodies are currently developing legislation to protect public and industrial workers from the effects of radiation hazards. Speed of going forward with the standards program is urgent, so that these groups as well as industry can have nationally uniform standards available.

The American Standards Association is the national clearinghouse for voluntary industrial and consumer standards. It is a federation of 115 trade associations, technical societies, and public interest groups. There are also 2,300 companies affiliated as members.

New Computer Is Heart of Vast Air Defense System

The first large-scale computer for the nation's vast new electronic air warning network is being shipped from International Business Machines Corporation (IBM) new Kingston, N. Y., plant to McGuire Air Force Base in New Jersey. This extraordinary "electronic brain" will become the first of the giant computers to fit into the integrated complex of radar, ships, jet aircraft, communications networks, missiles, and people that is rapidly taking shape as the supersensitive continental air-defense system.

This Semi-Automatic Ground Environment (SAGE) system combines the abilities of the world's fastest electronic computer to receive information, memorize, calculate, and record answers with the perspective and display talents of radar to present an instantaneous graphic picture of the location, speed, and direction of all planes within radar range. With a knowledge of flight plans of friendly planes available in the computer, hostile planes can be identified immediately and the most effective defense action taken—again on the basis of computer information and instruction.

The computer was designed by IBM's Military Products Division Laboratory, Poughkeepsie, N. Y., in co-operation with Massachusetts Institute of Technology's Lincoln Laboratory, Lexington, Mass., and was manufactured at the company's Kingston Military Products Division plant. The plans for production were laid in 1953 by IBM, and the first machine is being completed and shipped in accordance with the schedule.

The SAGE system starts with a radar ring—on land, on Navy picket ships at sea, on offshore Texas Towers, and on airborne early warning planes, ranging far out over the ocean. These radars are linked by telephone lines or uhf radio directly to the high-speed computer. Information about aircraft anywhere within the radar area is relayed continuously and automatically to the computer. This IBM-built equipment, called the *AN/FSQ-7,* digests all of this information plus Ground Observer reports, flight plans, and weather information as fast as it is received and translates it into an over-all picture of the air situation. These television-like pictures show the air battle as it develops and provide the basis for the necessary human judgments.

The computer automatically calculates for the operator the most effective employment of such defensive weapons as guided missiles, antiaircraft batteries, and jet interceptors. In the case of the intercepting jets, the aircraft is controlled by directions fed by radio directly from the computer to the automatic pilot in the plane. Missiles are controlled similarly. At any time, the air battle commander can have the computer display the over-all air situation or whatever part of it he wishes to monitor in detail. As the battle moves, information is transferred spontaneously to an adjacent computer.

The SAGE computer incorporates the most advanced electronic components. One of these is a high-speed magnetic-core memory, made up of thousands of tiny doughnut-shaped cores. Several cores in a row store a single word or number, and the identity of which is determined code fashion, according to whether or not individual cores in the row are magnetized. Data may be "read" into or out of this memory in millionths of a second, almost immeasurably faster than the speed of a hostile jet bomber, the computer also makes considerable use of such new and economical developments as printed wiring and miniaturized components. Many automated and semiautomatic manufacturing techniques are used throughout.

The *AN/FSQ-7* is designed to operate 24 hours a day, 7 days a week. Facilities are provided so that preventive maintenance can be performed on the machine while SAGE data continues to be processed.

Engineering models of the computer have been installed for several months at Kingston and at the Lincoln Laboratory, where the system is being tested.

Included among other contributors to the SAGE system are Western Electric Company, Bell Telephone Laboratories, and Rand Corporation of Santa Monica, Calif. The SAGE system was developed by scientists and engineers at Lincoln Laboratory under contract with the U. S. Air Force. This program is being implemented through the joint efforts of the USAF Air Materiel, Air Research and Development, and Air Defense Commands.

Maintaining U. S. Technical Strength

The National Science Foundation has released the text of a statement made by its director, A. T. Waterman, in reference to the establishment of a National Committee for the Development of Scientists and Engineers, which recently was announced by President Eisenhower.

In his statement, Dr. Waterman comments on the fact that there is evidence that the United States is becoming more and more dependent on science and technology for its cultural, economic, and defensive strength. Ever since the Geneva International Conference on the Peaceful Uses of Atomic Energy, greater efforts are being expended by all nations to increase their technical achievements.

He further stated that the United States has achieved its position of technical leadership through a small fraction of its people. Co-operation of Government, industry, and universities has been the mainspring of the leadership, inasmuch as only one half of one per cent of the population is comprised of scientists and engineers.

The shortage of technically trained personnel is a nation-wide problem which stems from the training of the youth in the schools. The formation of this committee will serve as a valuable mechanism to encourage state and local approaches to the problem, and as a means of securing action by stimulating non-Federal groups.

Every effort will be made to facilitate the activities of the committee whose membership list gives evidence of support by the scientific and engineering communities, Dr. Waterman concluded.

Electronic Flight System Is Developed for Jet Airliners

Development of a revolutionary electronic system, providing "hands off" automatic, precision control of commercial jet airliners flying between a relatively slow 100 mph and sonic speeds, was announced recently by the Sperry Gyroscope Company.

Design-tailored over an eight-year period to meet complex jet flight requirements, Sperry's flight control system is expected to provide turboprop and turbojet aircraft with levels of air safety and passenger comfort surpassing anything produced by the company in 40 years of automatic pilot development.

Incorporated within various new design concepts of the lightweight, transistorized system—called *SP-30*—are features such as:

(1) Simplified radio beam-coupling equipment which "ties" the control system to radio station facilities for automatic navigation, with the pilot monitoring flight through Sperry's integrated "pictorial" instruments.

(2) Inertial path damping, a secret development providing extremely close altitude, cruise, and radio guidance control required for jets.

(3) A "practically no-drift" gyro to insure automatic, pinpoint navigation even in normally hazardous polar regions.

(4) A special safety monitor which, together with beam-coupling equipment, may contribute greatly toward improving all-weather landing operations by help in minimizing the likelihood of "missed approaches" to runways.

Development of flight control systems along advanced engineering principles is essential in meeting jet airliner requirements just as new aircraft-design concepts were essential to capitalize on the increased power of jet engines.

In a wide departure from conventional autopilots, the *SP-30* comprises a newly developed servo system and strategic use of special acceleration responsive devices for split-second sensing of minute deviations of an aircraft from its flight path.

Acceleration sensors, together with a velocity servo system, provide accurate and positive control of an aircraft's rudder, elevator and ailerons and preclude any possibility of loose or ineffectual control, it was noted.

A failure-proof control unit regulates the maximum force applied to the aircraft's control surfaces at all speed levels and a Mach computer reduces signal sensitivity in the sonic speed ranges to insure safe, smooth, and effective flight control.

Subsystems for each control axis (rudder, elevator, and ailerons) are self-contained and completely isolated from other parts of the flight system. Foolproof reliability is attained with improved circuitry design, making possible uninterrupted system operation even in event of complete failure of certain system components.

The *SP-30* contains a safety monitor on each axis to guard additionally against electrical malfunctions which may cause unwanted disturbance in flight. These computing units automatically disengage the control system before the aircraft responds to an erroneous signal.

These developments achieve such new, high degrees of safety and reliability that they significantly should improve airline landing operations by minimizing the possibility of "missed approaches" to runways in bad weather.

New Homogeneous Experimental Reactor at Oak Ridge

Construction is nearing completion on Homogeneous Reactor Experiment No. 2, an experimental nuclear reactor in the United States Atomic Energy Commission's (AEC) program to achieve economical atomic power. The reactor is located at the Oak Ridge National Laboratory in Tennessee. A homogeneous reactor differs from others in that its uranium fuel is in liquid solution rather than in solid form.

The core and pressure vessel assembly consists of a visible blast shield with spiral cooling coils, the pressure vessel proper, and an inner core vessel. The blast shield has an outer diameter of 6 feet, 3 inches and is made of *304* stainless steel, 1$^{1}/_{2}$ inches thick. The pressure vessel proper, which is enclosed by the shield, has an outside diameter of 5 feet, 9 inches and is made of carbon steel, 4 inches thick, with an inner *347* stainless steel cladding 1/2 inch thick. The core vessel, which is at the center of the pressure vessel, has an inside diameter of 32 inches and is fabricated from the zirconium alloy, zircalloy-2, 5/16 inch thick.

The fuel solution circulates through this zirconium alloy sphere where it becomes a critical mass and is heated by the fissioning uranium. The blanket solution circulates in the space between the zirconium alloy sphere and the stainless steel clad pressure vessel proper. A pressure of about 2,000 pounds per square inch is maintained in the pressure and core vessels to prevent the boiling of the blanket and fuel solutions.

The assembly was fabricated by the Newport News Shipbuilding and Dry Dock Company for the Oak Ridge National Laboratory which is operated for the AEC by the Union Carbide Nuclear Company.

The Homogeneous Reactor Experiment No. 2 is designed for a thermal output of 5,000 to 10,000 kilowatts of heat at temperatures suitable for generating steam for a turbine. It is expected to go critical and produce substantial amounts of heat before the end of 1956.

Control Systems Developed To Regulate Push-Button Industry

The best electronic control system, a new method by which industry can select from a series of 21 standard "building block" components, to regulate push-button manufacturing operations from remote points has been announced by The Sparks-Withington Company, of Jackson, Mich.

This novel method already is in use in the oil industry, in petrochemical plants, and in municipal water pumping systems providing a "brain" and a "nervous system" to control vital production operations. The modular units in the unique new method are inexpensively mass-produced, are hooked up merely by plug-in units which can be expanded or regrouped by semispecialist personnel, and utilize a single standard communications channel which can handle hundreds of control and supervisory functions even at distances up to hundreds of miles.

Most conventional control systems for inplant or outdoor monitoring functions require a large number of communications channels to accommodate varied or multiple functions. The innovation has far-reaching significance because it punches through the limits of existing control systems and provides a whole new set of highly flexible control tools which will make it possible to extend automation. A large percentage of industry's control applications can now be handled by the present units available in the assortment. Merely by connecting the strategic components dictated by the specific applications, companies can secure control systems at little cost.

Five standard control systems are now available utilizing the modular units: (1) automatic alarms, (2) remote metering, (3) discreet control, (4) proportional control, and (5) transmission systems. The systems will function over telegraph and carrier circuits and coaxial cable; and to span long distances or difficult terrain, radio and VHF, UHF, and microwave circuits can be used.

Citing the ease with which the systems operate over long distances, it is reported that the Shell Oil Company is using the standard components to comprise two applications near Chicago, Ill., to open and close pipe

ELECTRONIC BRAIN CONTROLS can be selected from a series of 21 standard "building block" components. The best electronic control system to regulate push-button manufacturing operations from remote points is illustrated (above) by J. J. Smith, president of The Sparks-Withington Company, developers of the unique process. Grouped in the foreground and held in Smith's hand are the 21 modular units. Control panel shows how certain strategic components are connected to enable companies to secure their control systems at costs of one half to two thirds less than the traditional custom-fabricated units.

line valves, one from a control board 25 miles away.

By proper selection of the right prefabricated modular units, industries can build their own systems which are versatile enough to measure and transmit operational information to distant control centers.

Two main classes of systems may be provided using the Spartan modular units: completely automatic, and centrally controlled where a single operator can check the condition of a whole manufacturing process by glancing at an integrated control panel incorporating meters, indicator lights, or a variety of alarm signals.

They will control processes operated electrically, mechanically, pneumatically, or hydraulically; and are sufficiently sensitive to regulate fractional horsepower motors as well as powerful enough to control 1,000 horsepower units or more.

Routine maintenance checks are required no more than three times a year and can be carried out by plant electricians merely using a test meter and logging readings which are compared to fixed performance standards.

Maintenance of the modular units is on a calendar basis with standard units simply unplugged and spares plugged in until the original unit is serviced and reinserted into the system. Recommended replacement time cycles are after 10,000 hours of service, or 415 days of use.

The technique is engineered to provide up to 125 channels of control in the resulting systems, in a progression of 10, 25, 50, 100, and 125 channel systems.

In a normal 10 channel system, over each channel, it is possible to effect control of eight different functions. In a typical system for the petrochemical industry or a municipal water pumping station, these eight functions might operate as follows. A key is depressed at the control board and (1) pump turns on; (2) signal flashes back, light turns on control board signalling pump functioning; (3) if pump malfunctions, alarm light turns on; (4) bearing temperatures are reported on and four lights report on two motor bearings and two pump bearings; (5) signal reports that pump is building up pressure; (6) signal will report on the correct value of the pump pressure reading, or an alarm warning will sound for incorrect pressure; (7) control order is transmitted which opens valve to any predetermined degree; and (8) can increase or decrease the open valve position in very small increments—all from miles away.

Bank Records Available to All Branches

The first completely automatic electronic savings bank system ever to be built will be installed in the Howard Savings Institution of Newark, N. J. This announcement was made by W. L. Maude, president of the Howard and S. J. Sindeband, president of The Teleregister Corporation of Stamford, Conn., a subsidiary of Ogden Corporation. Teleregister designed this system in conjunction with representatives of the Howard Savings Institution of Newark and 35 other large mutual savings banks.

The system uses the techniques perfected by The Teleregister Corporation in its electronic data processing systems, employing magnetic storage or "memory" drums and tapes to control accounts, print pass books, display uncleared check conditions, and "lock up" in the event of an overdraft. The principal advantage of this system is that the teller can have access to central inventory showing the status of any account, at any time, instantaneously, on demand. It is estimated that this will result in a 30-percent reduction in the teller's time required to perform a transaction, thus providing more rapid service to customers.

The network is completely integrated so that tellers at any of the 5 branch banks and at the main office of The Howard Savings Institution can take deposits or make withdrawals and immediately record this information on the central storage equipment in the main office of the bank. When a deposit is made at the branch bank and the account is maintained at the main office or at any other branch, this deposit must be forwarded before the customer's account can be credited. Before a customer can make a withdrawal at a branch, other than the one in which he maintains his account, it is necessary for the teller to telephone that particular branch to verify the customer's balance. With the new Teleregister system, deposits and withdrawals can be recorded within a second.

The use of the system will enable the banks more closely to predict their operating costs without provision for certain contingencies. Inasmuch as this system is leased by the bank and maintained by The Teleregister Corporation, the bank's operating cost is frozen at the rental figure. The bank is not required to make a large capital outlay and is spared the necessity of recruiting and training the specialized maintenance personnel.

The new Howard system is capable of handling up to 4,500 transactions per hour, and bank tellers are provided with instantaneous visual and printed reference on as many as 250,000 regular savings accounts. However, it was pointed out that this system was designed specifically for the Howard Savings Institution, that the capacity could be changed to meet the requirements of any banks contracting for this new Teleregister service.

Air Force Radome Test Range

A test range to provide the Air Force with a central location to study the effects of radomes on aircraft radar performance is nearing completion at the Air Research and Development Command's Wright Air Development Center (WADC).

The most complete such facility in the United States, it will assist the WADC Electronic Components Laboratory in solving problems in transmission-reflection, beam pattern distortion, and bore sight error. The latter two problems could not be satisfactorily studied at WADC before construction of this new $500,000 facility.

The test range will consist of three different and independent units. Each unit will hold a radome on a mount, tilting and rotating it around a radar test antenna. This will permit the microwaves to pass through all portions of the radome. The new facility will thus enable the Air Force to study all types of airborne radome design.

The transmission-reflection unit is used to determine the percentage of microwave energy transmitted for effective use, and the percentage reflected because of the radome. In this test, a microwave beam is transmitted through the moving radome to a fixed receiving antenna 50 feet distant. The amount of energy reaching the receiving antenna is compared with the amount that reaches the antenna when no radome is used. Also, the amount of energy reflected by the radome is recorded. This test shows which portions of the radome permit maximum transmission and which portions must be modified to improve transmission.

Beam pattern distortion, experienced by search, navigation, and bombing radar systems, is studied on the second unit. The microwaves are transmitted 1,900 feet across a shallow valley to a test tower where the radome is mounted over a receiving antenna. As the waves pass through the moving radome, their beam pattern is recorded by the receiving antenna which moves in unison with the radome. This test enables distortions in the beam pattern (which ideally is shaped like a giant tear drop) to be pinpointed and studied, and permits modification of future radome design to reduce distortion.

The third unit, still under construction, will be used to study bore sight (directional) error, a problem in streamlined radomes for armament fire control and missile guidance systems. In this test, a narrow "pencil beam" of microwave energy will be transmitted through the moving radome to a tracking target antenna 40 feet distant. As the beam passes through the radome, it is deflected, much as light rays are deflected when passed through curved glass. The target antenna will then seek out the point to which the beam has been deflected. The movement of this antenna will chart the magnitude, direction, and rate of change of the deflection. This will enable future radome design to be modified to reduce deflection.

A test range building, which houses all charting equipment and two of the three radome mounts, has been constructed to permit testing in almost any weather.

Survey Pinpoints Some Reasons for Engineer Shortage

The national shortage of engineers is commonly attributed to the disinterest of high school students who shun the rigors of higher technical education. Now another cause for the shortage has been found at the other end of the ladder.

A recent survey of Carnegie Institute of Technology revealed that a majority of science and engineer alumni are functioning in the higher echelons of administration and management.

Questionnaires were sent to some 18,000 alumni now residing in all the United States and many foreign countries. A record 95 per cent were returned.

Roughly two thirds, or 11,500, of the alumni hold bachelor, masters, or doctoral degrees in engineering or science but only 2,391, one fourth of those holding such degrees, listed their occupation as engineer.

The alumni, which also include graduates of the College of Fine Arts, the Printing Management School, and Margaret Morrison Carnegie College, reported 1,240 distinct occupations.

There were 329 corporation or company presidents, 357 vice-presidents, and 349 general managers. Engineers have chosen careers in the fields of editing, sales, education, medicine, law, and politics. Some 20 graduates had become clergymen, three others are missionaries. There are one each, U.N. delegate, ambassador, and rear admiral. C. E. Wilson, U.S. Secretary of Defense listed his occupation as secretary.

The survey uncovered 123 alumni who were unemployed, but closer scrutiny revealed most of these were between jobs or were free lance writers, actors, and artists.

Carnegie alumni work for 3,644 employers. Only two of these, United States Steel and Westinghouse Electric, engage more than 500, and only eight employ more than 100 Carnegie alumni.

The 2,391 graduates who listed their profession as engineer formed the second largest group. First came the 3,245 alumnae who gave their occupation as housewife.

Closed-Circuit TV Permits "Remote Visiting" in Hospitals

HOSPITAL PATIENTS visit with persons not allowed in rooms, such as children under age or those endangered by a communicable disease, with this new closed-circuit "Visit-Vision" television system. Patient at Morristown (N. J.) Memorial Hospital talking to her young son who appears on monitor at bedside.

In most hospitals throughout the country, children under 14 years of age are not permitted and yet many of the patients are parents or close relatives who would like to be able to see and visit with them. The "Visit-Vision" system gives the patient an opportunity to see the young callers who may, of course, talk over the telephone to the patient and who may see in the receiver a picture of themselves so that they know what kind of a picture is being transferred to the patient upstairs.

A standard *60-B* camera and a *602* monitor are placed in a triangular booth that is approximately 6 feet on a side. A telephone is placed at the booth. The output of the camera is fed through the monitor to the main distribution point of the hospital's television distribution system. Here, it is fed into an unused channel. In the Chicago area, where channels 2, 5, 7, 9 and 11 are used, the Visit-Vision signal is sent through the hospital distribution system on channel 3½ in order that this double side-band signal may be transmitted without cross talk problems. In any particular locality, an appropriate channel can be found. It is possible to use a lens which will completely encompass the area in which the visitor may stand and the visitor will remain in focus. Fluorescent lights are placed at the sides of the booth giving satisfactory illumination.

In those areas where no master television signal distribution system exists at present in the hospital, special receiving points may be set up and it is also possible to set up a two-way conversation system with a camera at each end of the conversation but this is somewhat more expensive. The need for one-way opportunity for the patient to see the caller is much more important than for the caller to see the patient. The system has application not only for children in hospitals but for absolutely controlling visits to patients who must see a limited number of people and must see them for limited periods of time. The system also has great potential value in psychiatric wards and certain other special situations as, for instance, where the patient has been very badly burned or is undergoing extensive facial surgery or is in an iron lung. Developed by ITV, Inc., New York distributor of closed-circuit TV equipment manufactured by Dage Television Division, Thompson Products, Inc., Michigan City, Ind., the unit, complete with self-contained camera, monitor and special booth, costs approximately $2,500.

LETTERS TO THE EDITOR

INSTITUTE members and subscribers are invited to contribute to these columns expressions of opinion dealing with published articles, technical papers, or other subjects of general professional interest. While endeavoring to publish as many letters as possible, Electrical Engineering reserves the right to publish them in whole or in part or to reject them entirely. Statements in letters are expressly understood to be made by the writers. Publication here in no wise constitutes endorsement or recognition by the AIEE. All letters submitted for publication should be typewritten, double-spaced, not carbon copies. Any illustrations should be submitted in duplicate, one copy an inked drawing without lettering, the other lettered. Captions should be supplied for all illustrations.

Beams on Empire State Tower

To the Editor:

The interesting account of the new light beams on the Empire State Building in *Electrical Engineering*, May 1956 indicates that it is estimated "that beams of light. . . could be seen by persons. . .in Connecticut, approximately as far as Bridgeport. . . an 80 mile arc from the installation."

This is open to challenge for Bridgeport is not more than 56 miles from 34th Street. The error should be noted to avoid confusion in the minds of future generations of historians.

SIDNEY WITHINGTON

Kilowatt-Hour Weight

To the Editor:

Mr. B. J. George's computations in the March 1956 issue entitled "Electrical Oddities" concerning the weight of a kilowatt-hour is interesting, but calls for some criticism.

In his computation Mr. George uses a mixture of modern metric units and ancient units, such as pounds and ounces. This makes it difficult to follow and should be avoided. Whey not use cgs system throughout. It is so simple to use. (I think that it is about time we adopt a decimal system of measures, such as the metric system.)

I do not understand the computations in section 2C; "One 100-watt lamp at 110 volts = 0.9 amp . . .", and the results "One kilowatt-hour at 110 volts = 32,400 coulombs = 202 × 10^{21} electrons." Now what happens to that 110 volts?

His method of computation shows clearly that the number of electrons is inversely related to the voltage value being chosen, thus changing the mass accordingly. Why 110 volts or any voltage at all?

The end result of 4 × 10^{-7} pounds per kilowatt-hour is, therefore, incorrect.

I do not know any method which could be used in such computations, excepting the Einstein's formula for the equivalence of mass and energy

$$E = mc^2 \text{ ergs}$$

where m = mass in grams
c = velocity of light in centimeters per second. (Speed of light has been taken as 3 × 10^{10} cm per second. Latest measurements show c = 2.9979. . × 10^{10} cm per second).

Using this formula we get the mass for a kilowatt-hour as follows:

$$1 \text{ Kilowatt-hour} = 36 \times 10^{12} \text{ ergs}$$

(1 wattsecond = 1 joule = 10^7 ergs)

$$m=\frac{E}{c^2}=\frac{36\times10^{12}}{9\times10^{20}}$$

$$= 4 \times 10^{-8} \text{ grams}$$

(4 × 10^{-8} grams = 8.818 × 10^{-11} pounds)

Mr. C. E. Rose in *Electrical Engineering* May 1956 issue, prefers to use the physical mass unit. This unit is 1/16 of the atomic weight of the most abundant isotope of oxygen (O-16). (I suggest that the physical mass unit should be changed to be 1/75 of the atomic weight of natural arsenic (As-75). An obvious advantage in nucleonic calculations.) It is about 1.66 × 10^{-24} grams in mass. The usual figure for the mass (m_0) of electron is about 5.49 × 10^{-4} millimicron.

One gram of any known matter is equivalent to

$$E = 1 \times 9 \times 10^{20} = 9 \times 10^{20} \text{ ergs}$$
$$= 25 \times 10^6 \text{ kilowatt-hours}$$

As to the price of electric energy I have seen wholesale prices as low as 0.2 cent per kwhr (water power) and retail prices at a rate as high as $1,000 per kwhr (at $1 minimum charge per month, one watt-hour consumption per month, when I was on vacation and away, figures $1,000 per kwhr), so take your choice in figuring, such as the price for a ton of "Reddi-Kilowatthours."

Furthermore, justification of the use of Einstein's formula for this type of computation needs some serious thinking. I will let the reader reach his own conclusions after he analyzes the following.

Mass in rest m_0 represents, of course, potential or imaginary energy. If we give a value for this energy we have to consider other associated conditions, for example: the location of the mass and its possibilities in producing kinetic energy, etc.

Mass in motion represents kinetic energy and follows the law of mechanics

$$E_{\text{kinetic}} = {}^1/_2\, mv^2$$

where v = velocity of the moving mass m.

The Einstein formula for equivalence of mass and energy is

$$E = mc^2$$

Lorentz's principle of variable mass of electron is expressed as

$$m_m = m_0\,(1 - v^2/c^2)^{-1/2}$$

where

m_m = mass in motion
m_0 = mass in rest
v = velocity of the electron
c = velocity of light

If we now modify the Einstein formula by replacing the m by m_m we get

$$E = m_0\,(1 - v^2/c^2)^{-1/2}\,c^2$$

By solving, we will see that when the velocity of the electron approaches that of light, the energy increases enormously, and becomes infinite when $v = c$.

This might mean (1) that the electron cannot be forced to travel as fast as light, or (2) that when the speed approaches the value of c, the enormous swelling of the electron mass will cause an explosion and/or destruction of the solidity, or (3) that there are enormous forces present at the close proximity of the upper limit, $v = c$. It also might mean that there is no justification for the use of Einstein's theory of equivalence of mass and energy in this type of computation, which deals with electron speeds at the industrial level.

I hope that Mr. George's letter will get a large response, so that this interesting subject will thoroughly be discussed and perhaps enlarged in its scope.

Very truly yours,

ERNST J. MOMMO (AM '13, M '24)
(Retired)

NEW BOOKS

The following new books are among those recently received at the Engineering Societies Library. Unless otherwise specified, books listed have been presented by the publishers. The Institute assumes no responsibility for statements made in the following summaries, information for which is taken from the prefaces of the books in question.

GERMANIUM DIODES. By S. D. Boon. Philips Technical Library, Eindhoven, Holland, 1956. 85 pages $5^3/_4$ by $8^1/_2$ inches, paper. $1.95. A concise, essentially practical treatment containing only enough theory for an understanding of the diode, for the analysis of commonly occurring problems, and for the design of circuits. In addition to dealing with characteristics and properties, the book covers the uses of diodes as rectifiers, switching elements, and demodulators, and includes technical data on various Philips' diodes. Also given are some examples of practical applications in electrical engineering.

KLEINES HANDBUCH TECHNISCHER REGEL VORGÄNGE. By Winfried Oppelt. Verlag Chemie, Weinheim, Germany, second edition, 1956. 555 pages, $6^1/_2$ by $9^1/_2$ inches, bound. DM 36.40. This manual on industrial control systems describes the design and construction of the more important control devices and presents the mathematical fundamentals for the solution of control problems. Charts and diagrams are profusely used to illustrate the characteristics of the various devices and systems covered. The new edition has been considerably revised and enlarged, but the 600-item bibliography has been omitted owing to the availability of more comprehensive ones elsewhere. A shorter list of pertinent books and periodicals has been included.

MATHEMATICS REFRESHER FOR PROFESSIONAL ENGINEERS' AND LAND SURVEYORS' LICENSE. By J. D. Constance. Published by John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., first edition, 1956. Various paging, $8^3/_8$ by $10^7/_8$ inches, paper. $2. A collection of problems, with solutions, explanations, and illustrative diagrams, based on examinations given in a number of states. The problems cover the subject from algebra through calculus.

MATHEMATISCHE METHODEN IN DER HOCHFREQUENZTECHNIK. By Klaus Pöschl. Springer-Verlag, Berlin, Germany, 1956. 331 pages, $6^3/_4$ by 10 inches, bound. DM 36. This combined text and reference work on mathematical methods in high-frequency engineering utilizes two approaches. The first 11 chapters deal with the various mathematical operations including sample applications: functions of a complex variable, Fourier and Laplace transformations, statistical operations, differential equations, and other special functions. The last four chapters demonstrate the various operations as applied to cavity resonators, wave conductors, radiation fields, and electron streams.

NOTES: Basic Engineering Sciences. By C. E. Harrington. Published by the author, 45 Elk Street, Springville, N. Y., third edition, 1956. 161 pages, $8^3/_8$ by 11 inches, paper. $3.50. Intended as an aid to engineers preparing for New York State professional engineering examinations, this publication briefly reviews fundamentals and illustrates methods of solutions of problems by including 263 answered questions from previous examinations.

OFFICE WORK AND AUTOMATION. By H. S. Levin. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1956. 203 pages, $5^7/_8$ by $9^1/_4$ inches, bound. $4.50. A discussion, for business executives, of the possible applications to office work of new methods of handling information. Five-channel punched paper tape, punched cards, and magnetic tape are suggested as methods for integrated data recording; electronic data processing machines are considered as tools for processing information; and operations research is discussed as an approach to the effective use of information. The probable effects of mechanization on management control, office organization, and employees are explored in the last chapter.

PAMPHLETS

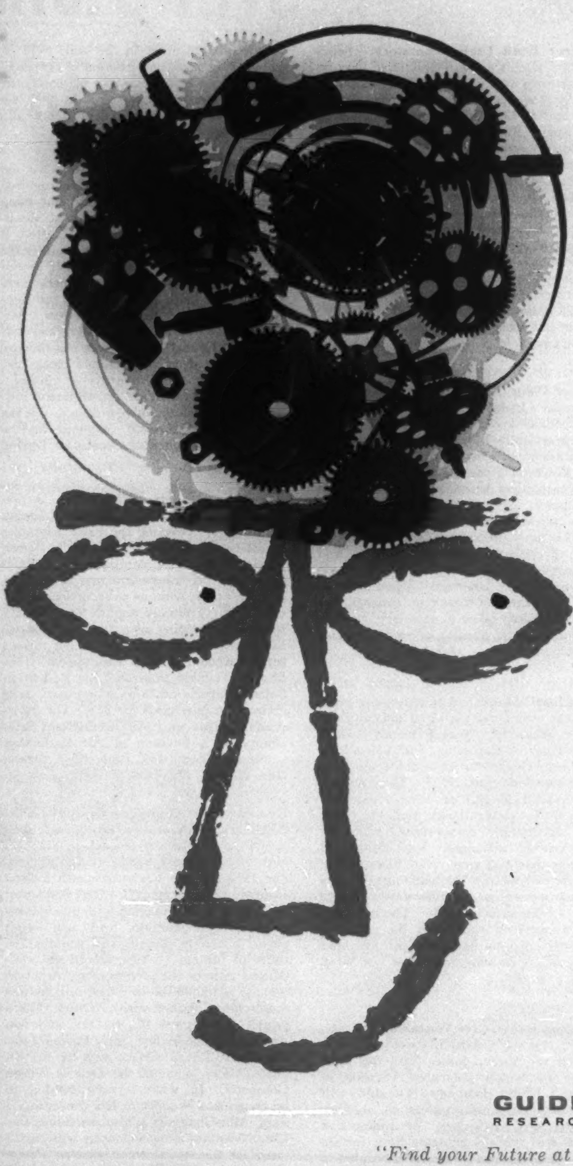
The following recently issued pamphlets may be of interest to readers of "Electrical Engineering." All inquiries should be addressed to the issuers.

Record Houses of 1956. Prepared by the editors of *Architectural Record*, a professional magazine published for architects and engineers, this booklet presents to the "home-building, home-buying" public, as well as to the architects designing houses, a comprehensive picture of the best houses from all parts of the United States—houses that have been approved for comfortable living by the average sized families that are presently occupying the dwellings. Graphically illustrated with 267 photographs, plans, and drawings, including eight pages in full color, it features four major editorial sections: part one introduces the editors' "American House"; part two has 20 of the latest architect-designed houses; part three includes 8 experimental houses also designed by architects; and part four features building products and literature. $2.95. Published by F. W. Dodge Corporation, 119 West 40th St., New York 18, N. Y.

Engineering Enrollments and Degrees, 1955. This circular consists of texts and tables presenting information relating to undergraduate enrollment and degrees, and graduate engineering enrollment and degrees. 1956, 35 pages. Catalog number *FS 5.4:468* may be ordered for 30¢ per copy from Superintendent of Documents, U. S. GPO, Washington 25, D. C.

Brazing Characteristics Studies for Heat Resistant Alloys. This Air Force research report discusses 15 different alloy systems, tested and studied for brazing characteristics and chemical and physical properties. The alloys studied were nickel base binary and ternary systems containing such metals and metalloids as phosphorus, silicon, chromium, manganese, molybdenum, tungsten, and iron. The researchers found that phosphorus and manganese contributed the most toward improving the flow and wetting properties of the alloys, while silicon and chromium contributed the most toward improving the oxidation resistance and strength properties of the alloys. The nickel-phosphorus-chromium and nickel-phosphorus-silicon systems showed the best properties of the phosphorus bearing alloys. The nickel-silicon-manganese system showed the best properties of the silicon bearing alloys. Silicon bearing alloys in general are higher melting than the phosphorus alloys. This 73-page illustrated report, *PB 121001*, by F. M. Miller and others, Wall Colmonoy Corporation for Wright Air Development Center, is available from OTS, U. S. Department of Commerce, Washington 25, D. C., price $2.

The Role of Government in Developing Peaceful Uses of Atomic Energy. Published by the American Enterprise Association. In his examination of the role of Government in this field, the author, Dr. Arthur Kemp, compactly summarizes the Atomic Energy Acts of 1946 and 1954, the accomplishments and problems of the Atomic Energy Commission, the "Atoms for Peace" program, and the beginnings of private atomic industry. Close attention is given to the problems of secrecy and security. For the layman, as well as for the expert, this 50-page pamphlet is a remarkable condensation of the picture. This is the third study in the American Enterprise Association's series on "Big Government." $1 per copy. May be ordered from American Enterprise Association, Inc., 1012 14th St., Washington 5, D. C.



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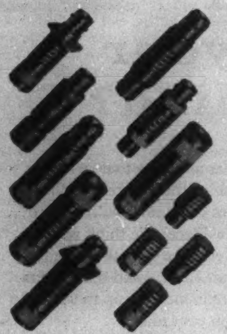

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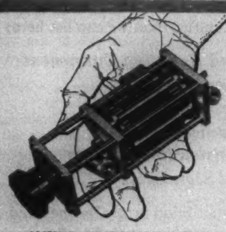
This new group of pads and terminations features the popular Types C and N connectors, and permits any conceivable combination of the two styles.



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INDUSTRIAL NOTES ...

Sperry Rand Utah Laboratory. Selection of Utah's capital, Salt Lake City, as the site of a huge research and development facility, to begin local operations before the end of 1956, has been announced by the Sperry Rand Corporation. One of the nation's foremost electronic and weapons systems producers, the company declines to state specific projects already assigned to its first Utah activity. More than half of the building will be air conditioned for critical laboratory research and precision testing of experimental designs. Scientific instruments and special machine equipment will be installed before full operations are reached about January 1957. Early in 1957, planned employment of 300 engineers and technical personnel is expected to be complete.

Power Plant To Be Built. Authorization to build a hydroelectric power plant of at least 60,000-kw capacity on the Roanoke River at Smith Mountain in Virginia has been announced by the Appalachian Electric Power Company, a subsidiary operating company of American Gas and Electric Company. Needed steps include immediate application to the Federal Power Commission for a preliminary permit, completion of explorations of the damsite, and arrangements for disposition of roads affected by the reservoir. Upon satisfactory completion of these requirements, and the obtaining of any necessary governmental consents, licenses, or authorizations, construction will be undertaken.

"Nuclear" Metals. A tube forming process that overcomes the usual difficulties of cold working the "nuclear metals," uranium, titanium, zirconium, and their alloys, has been reported by Tube Reducing Corporation, Wallington, N. J. These metals, which tend to gall or seize when cold worked by conventional methods, have been successfully compression-formed by "Rockriting" machines. Raw tubing fed to these machines were rough, nonuniform tubular extrusions. The cold finished tubes produced were long precision sized cylinders with a high surface finish. The excellent results obtained eliminated the need for expensive vacuum annealing, pickling, and trimming operations as well as low scrap loss.

Study on Radioactive Waste Control. An engineering study on radioactive waste control for the United States Navy has been begun by Kaiser Engineers Division of Henry J. Kaiser Company. The study will evaluate several alternatives on absolute control and disposition of radioactive liquid and gaseous effluents from certain research operations which are scheduled to be undertaken by the United States Naval Radiological Defense Laboratory in San Francisco, Calif. The work will be undertaken by the Nuclear Engineering Division of Kaiser Engineers in Oakland, Calif. whose other projects in the same field include design and construction of the Engineering Test Reactor for the United States Atomic Energy Commission at the National Reactor Testing Station, Idaho Falls, Idaho.

Improved Consulting Services. To aid and instruct customers in achieving best results from refractory metals and components made from them, Fansteel Metallurgical Corporation has established a Metallurgical Consulting Service under the direction of R. W. Yancey, chief metallurgist. This new service will operate entirely in the field, supplementing and augmenting customer technical services. Mr. Yancey has been on the metallurgical staff at Fansteel since 1945. Before this time he was associated with the atomic energy development at the University of Chicago, the steel cartridge case development program, and the automotive industry. He is a graduate metallurgical engineer and a member of the American Society for Testing Materials.

Arcwelding Safety Slide Film. A 20-minute, sound slide film, entitled "Always on the Job," covering the basic principles of safety in electric arcwelding has been produced by The Air Reduction Sales Company. A companion film to Air Reduction's prize winning oxyacetylene safety slide film, "The Guy Behind Your Back," the new arcwelding safety film also features the light, cartoon approach to this serious topic. Record is $33^{1}/_{3}$ rpm speed. This film is available from any Air Reduction Sales Company office on a free-loan basis or may be purchased for $15. For information write to: Air Reduction Sales Company, a Division of Air Reduction Company, Inc., 150 East 42nd Street, New York 17, N. Y.

Record Size Condensers by Allis-Chalmers. The world's largest single shell surface condenser, a 200,000-square foot giant is scheduled for shipment in September 1957, to the Commonwealth Edison Company in Chicago, Ill. This condenser to be used in conjunction with 300,000-kw steam turbine-generator unit, will weigh about 1 million pounds and contain 166 miles of tubing. Other record-size condensers now in the process of construction include a 180,000-square foot unit in two shells for Commonwealth Edison Company's Waukegan, Ill., station, and two single shell condensers, each having 170,000 square feet of surface area for the St. Clair, Mich., plant of the Detroit Edison Company. In what is now coming to be recognized as more or less conventional sizes, Allis-Chalmers is also providing two 130,000-square foot condensers with auxiliaries for the Appalachian Electric Power Company's new Clinch River plant in Virginia, and two 100,000-square foot units for the Kammer plant of the Ohio Power Company south of Wheeling, W. Va.

(Continued on page 18A)

Microwave
KEEPS UTILITIES ON THE BEAM

In a tremendous surge of expansion, electric utilities are putting up new installations essential to the national economy, right across the nation.

RCA Microwave is providing these utilities with dependable communications systems, easily expandable, capable of handling every vital communication function including voice, teletype, telemetering, supervisory control, load control, relaying and transfer trip, facsimile, remote control, operation of mobile radio and others.

Through the use of microwave, voice or data intelligence reaches every part of the territory served and the whole system can be under the dispatcher's immediate control.

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ON TURNPIKES—On the new cross-country superhighways RCA Microwave provides circuits for voice, facsimile, teletype, VHF control, traffic information and business machine communications . . . gives operating personnel complete control of the road, greater safety and service to driver patrons around the clock, in fair weather or foul.

RCA MICROWAVE provides the most advanced engineering features. Provision for the easy addition of future channels makes it the least expensive form of communication per channel mile. Equipment uses easy-to-service, familiar circuits and readily available tubes. Single sideband suppressed-carrier frequency division multiplex is used exclusively to meet high standards of dependability and quality of transmission. Frequency control for the system is concentrated at the terminal stations. And only *two* frequencies are usually required. Furthermore, RCA provides the nation-wide service of the RCA Service Company to keep your system operating at its peak.

RCA Microwave Representatives, with years of microwave experience, will be glad to answer any questions and to assist in planning your installation. Mail coupon for further particulars.

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RCA MICROWAVE is easily interconnected with mobile radio installations as well as existing telephone lines and switchboards. Field maintenance crews, no matter how remotely located, can be contacted from any station or office. Instant communication in the field means hours per day saved in parking, backtracking and preventing costly delays.

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Industrial Notes

(Continued from page 14A)

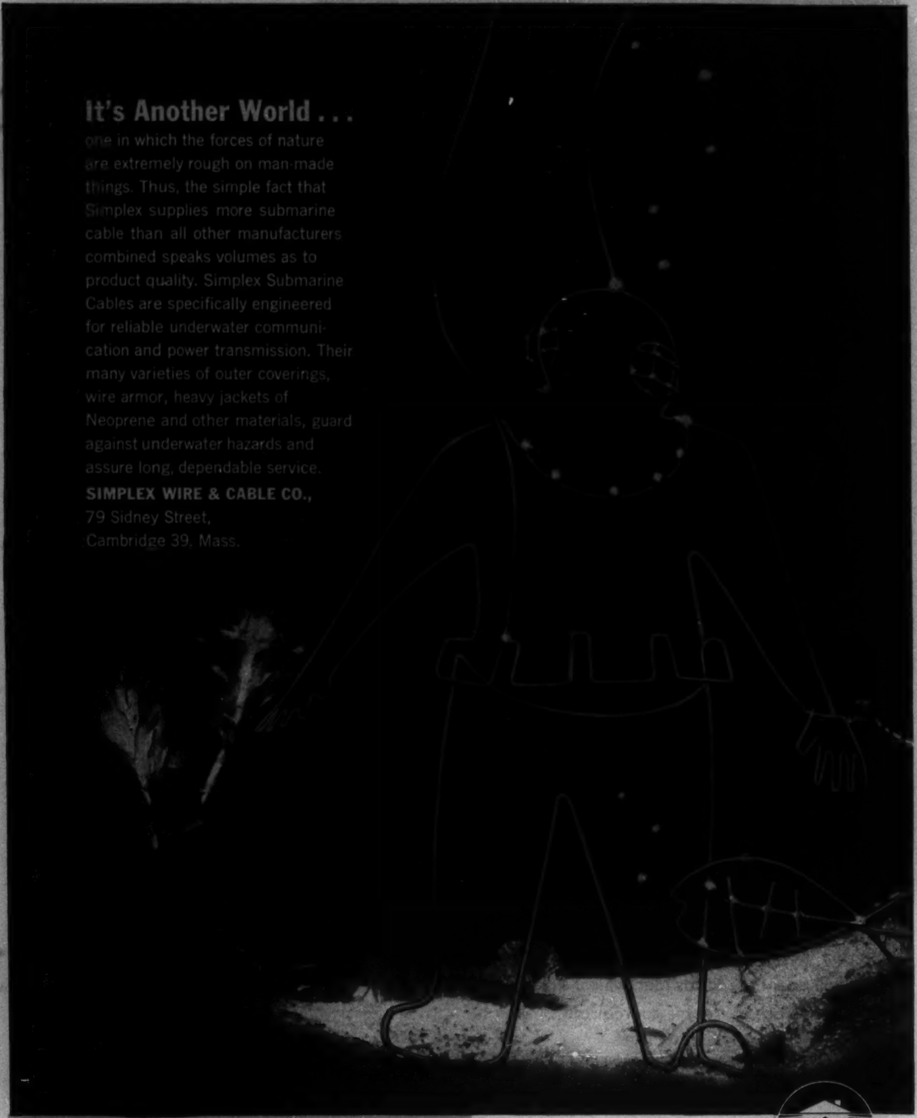
Electronic Controls for Largest Supersonic Wind Tunnel. The world's largest supersonic wind tunnel is now under construction at the Air Force's Arnold Engineering Development Center at Tullahoma, Tenn. Stromberg-Carlson, a Division of General Dynamics Corporation, will provide the electronic equipment for controlling the flow of air in it. The wind tunnel will provide air velocities up to four and a half times the speed of sound. It will be of the continuous flow type, which means that it can be operated for periods of several hours at a stretch, rather than the three or four minutes usually available with supersonic wind tunnels of the blowdown type. Its testing chamber will be 16-feet square. Existing supersonic tunnels are measured in inches. General Dynamics is to design and construct a control system for the nozzle of flexible ducting which will regulate the flow of high velocity air through the actual testing chamber. Stromberg-Carlson is to create a digital computer system for automatically controlling the shape of the nozzle by electronic means.

Hydroelectric Site Named. The site of the Shawinigan Water and Power Company's newest hydroelectric development, Rapide Sans Nom or the rapid without a name, has been named Rapide Beaumont by the Quebec Geographical Commission. It is on the St. Maurice River about 10 miles above La Tuque. Announcement of the naming of the rapids after R. J. Beaumont, chairman of the Board of Directors of the Shawinigan Company, was made in a directive by the Commission. Immediately following the provincial government's move, J. A. Fuller, president of the Shawinigan Water and Power Company, announced that the new hydroelectric plant at the site, construction of which has started, would now be known as the Beaumont development. The plant will have an ultimate capacity of 246,200 kw and first power is scheduled to be produced late in 1958.

Production of Radar Data Transmission System Started. Skiatron Electronics and Television Corporation has received a production order for its newly developed Radar Data Transmission System (RADAT). RADAT is a system whereby radar signals can be picked up from outlying radar screens and transmitted with accompanying identification and other pertinent data over existing telephone lines to any desired central control location. Its potentials in the important field of air traffic control already have been widely recognized. With RADAT a strategically located control center can be quickly established wherever it is desired to keep a large area under radar operation, and where it is desirable that instantaneous identification and other intelligence regarding radar targets be transmitted to the center from outlying radar stations.

(Continued on page 20A)

Wire Sculpture by Henry Szafarz



It's Another World . . .

one in which the forces of nature are extremely rough on man-made things. Thus, the simple fact that Simplex supplies more submarine cable than all other manufacturers combined speaks volumes as to product quality. Simplex Submarine Cables are specifically engineered for reliable underwater communication and power transmission. Their many varieties of outer coverings, wire armor, heavy jackets of Neoprene and other materials, guard against underwater hazards and assure long, dependable service.

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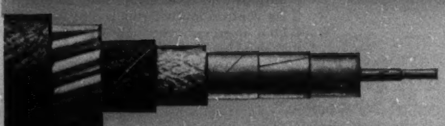

Photo of Transoceanic Telephone Cable, Cut Back to Show Construction

LIVE BETTER ELECTRICALLY

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DOUBLE-THROW DUAL CIRCUIT BREAKER DESIGN

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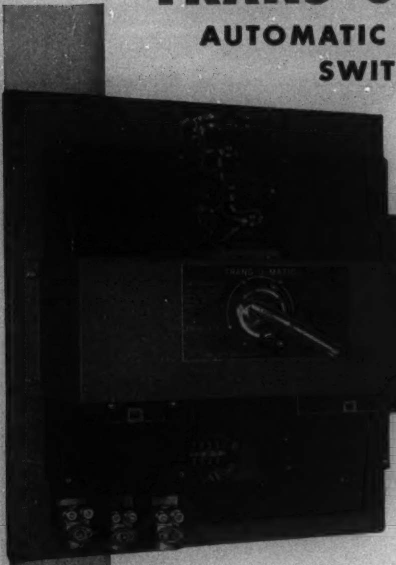
AUTOMATIC TRANSFER
SWITCH



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- **Full range to 50,000 amp. interruption capacities, 600 V. 800 A. loads.**
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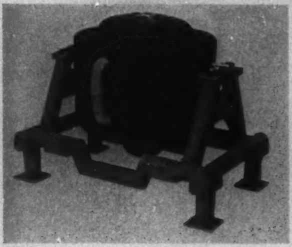
OPTIONAL . . . adjustable time delay . . . engine starting contact . . . test pushbutton . . . pilot lights for switch position . . . special enclosures.

LAKE SHORE *Electric* CORPORATION
200 WILLIS AVENUE
BEDFORD, OHIO

(*Continued from page 18A*)

NEW PRODUCTS

New 1,500-Pound Vibration Shaker. Design of the second in a series of new shakers has just been completed by the Calidyne Company of Winchester, Mass. Shakers of this series are specifically designed for higher frequency operations and lower input requirements. The new model *174* shaker is featured in a system for random vibration testing of components and assemblies up to approximately 30 pounds in weight. The inherent rigidity of the armature maintains a high first resonance under loaded conditions. The model *174* shaker features an armature having its longitudinal resonance at approximately 4,000 cycles per second, bare table. Additional features of this new model *174* 1,500-pound-force output shaker include: collinear table motion, table diameter of 9 inches, 130 pounds load for 10-g vector and 55 pounds load for 20-g vector, maximum stroke of ±0.5 inch with recommended stroke of ±0.25 inch for continuous duty. Field supply requirements are 3 kilowatts at 125 volts, d-c. When used with amplifiers, a separate rotary motor-generator set is supplied. Weight of this new shaker is 2,000 pounds. For further details write the manufacturer.



Oscillograph. Model *560* oscillograph is the result of an extensive stress analysis and test program conducted to produce an instrument that would record under extreme acceleration and shock conditions. This model has successfully recorded impact shocks in excess of 3,000 g both in laboratory and field tests. It is packaged in compact case. Some features of this new instrument are: rugged cast aluminum case and magazine, 14 channels of data available, mounting brackets cast integral with oscillograph case, all operating controls and viewing screen accessible from one end, and the wide range of galvanometers available with natural frequencies up to 3,500 cycles per second. Complete details and specifications can be obtained by writing Midwestern Instruments, 41st and Sheridan Road, Tulsa, Okla.

(*Continued on page 25A*)

Mister, you're looking at a panelboard that's really built for Heavy Duty!

The heart of this QMB Saflex Distribution Panelboard is the quick-make, quick-break, horsepower rated switch unit.
It's loaded with features—

- Each switch unit individually enclosed in heavy gauge steel
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DEPOSITED CARBON RESISTORS
for high voltage and/or high resistance applications

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[illegible] Broadway, New York N.Y.
In Canada: [illegible]

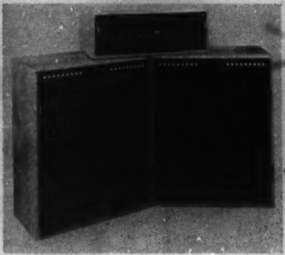
FOUR-CHANNEL CARRIER-TELEPHONE TERMINAL FOR RADIO LINKS

This is a miniaturized unit of advanced design which provides four voice channels on a frequency-division basis above a voice-frequency order-wire channel. Each of these five channels is provided with a 4-wire 2-wire termination and a voice-frequency ringing circuit for d-c or 20-cycle signals. Adjustable attenuators are provided in the 4-wire side of all channels, and a built-in test oscillator and meter permit complete line-up, maintenance and trouble-shooting checks to be made. Channel levels are from −9 to 0 dbm and line levels from −30 to 0 dbm. Channel width is 300 to 3500 cycles within 1 db.

This unit is only 5¼″ high by 19″ wide by 14″ deep. It mounts on a standard rack and operates from 115 volts 50-60 cycles a.c.

RADIO ENGINEERING PRODUCTS
1080 UNIVERSITY ST., MONTREAL 3, CANADA
TELEPHONE UNiversity 6-6887
CABLES RADENPRO MONTREAL

(Continued from page 25A)

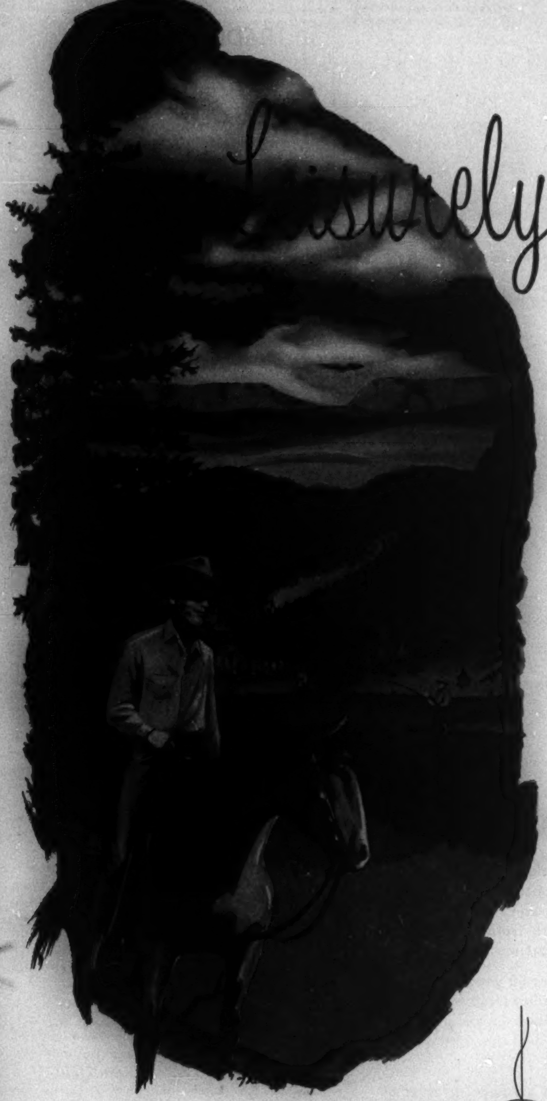


this equipment. GPS general purpose simulators can perform complete problem solutions up to 50 times per second, allowing the research operator to change problem parameters and observe instantaneously and continuously the resulting changes in problem solutions. They are particularly useful for the rapid study of alternative system configurations, for optimizing the parameters of a defined system, for the solution of boundary-value problems and for the trial-and-error design of any given physical system. For information write: Samuel Giser, chief engineer, GPS Instrument Company, 811 Boylston Street, Boston, Mass.

Heating System to Pipe Music through House. A central entertainment system now feeds sound from record player, television set, or radio into the warm-air heating system. Called "registered music," the system provides background music for every room in the house. Installation consists of running a wire from the existing location of a record player, television set, or radio to a specially developed electronic speaker attached to the plenum chamber or dome of any warm-air heating system or to air-conditioning ducts. The heat resistant, vibration free speaker broadcasts true-fidelity sound into the warm-air heating system and out through the warm-air registers throughout the house. No knowledge of electronics is needed to install the unit. Furthermore no special tools, skills, or other parts are needed. Literature describing the unit is available for the asking from Alsto Company, 4007 Detroit Avenue, Cleveland 13, Ohio.

Oscilloscope. This entire unit is only $5^1/_4$ inches high by 11 inches deep with a 19-inch width to mount in standard relay racks. The instrument responds from d-c to 300 kc and is flat from d-c to 150 kc. Horizontal and vertical amplifiers are identical and balanced. All operating controls are grouped for maximum efficiency and flexible performance. In testing situations where space is a problem, the *627R* is a perfect solution. For further information write Hycon Electronics, Inc., Pasadena, Calif.

(Continued on page 42A)



Los Alamos Scientific Laboratory is located in a delightful small city, high in the pine forests of northern New Mexico. It is a city of

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and Career Opportunities in Engineering

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Challenging problems in the design of weapon components, their fabrication and testing; design, control, and testing of reactors; support of programs in nuclear physics research including an intriguing variety of work in controls, machine design, gaging.

CHEMICAL ENGINEERS

Development and research in formulation and fabrication of new materials; design and preliminary manufacture of weapon components for systems testing; studies in fluid flow and heat transfer, particularly in systems at high temperatures and pressures, recovery and purification of radioactive materials by remote control processes.

ELECTRICAL AND ELECTRONICS ENGINEERS

Creative development of instrumentation for recording the history of events which occur in times as short as milli-microseconds; a wide variety of instrumentation including scintillation counters, fast pulse amplifiers, fast oscilloscopes.

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Work in these fields includes high temperature thermodynamics, properties of rare metals, development of high temperature fuels and structural materials for nuclear reactors, radiochemistry, radiation chemistry, uranium and plutonium metallurgy and chemistry, complex ion chemistry, microanalysis, isotopic analysis.

If you feel you are an above-average candidate, if you want to join the scientists at Los Alamos working at the very frontiers of their field, write:

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INTRODUCTION
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Above are just a few Morganite products designed to help the Electrical Engineer gain better performance, lower maintenance from his electrical equipment. Carbon, which is self-lubricating, resistant to burning and free from welding, is particularly suitable as an electrical contact material.

Carbon products have been our business for 50 years. Through constant research we have learned the peculiar traits and properties of various grades and qualities of carbon. This experience places us in a position to supply you with just the right grade and design for your particular needs.

Our engineers will be glad to discuss your electrical problems with you.

Morganite INCORPORATED

Manufacturers of fine carbon-graphite products for fifty years.
3306 48th Avenue, Long Island City 1, New York

(*Continued from page 30A*)

TRADE LITERATURE

Lightweight Handle. A new, lightweight handle for transit and carrying cases is described in a leaflet just issued by Skydyne, Inc., designers and manufacturers of engineered packaging for industry. The leaflet illustrates the aluminum and steel handle, which snaps back to built-in recess. Descriptions and dimensions of three models are also given. The handle meets *MIL-C-4150-A* and *MIL-T-945A* specifications. Copies are available at Skydyne, Inc., 1 River Road, Port Jervis, N. Y.

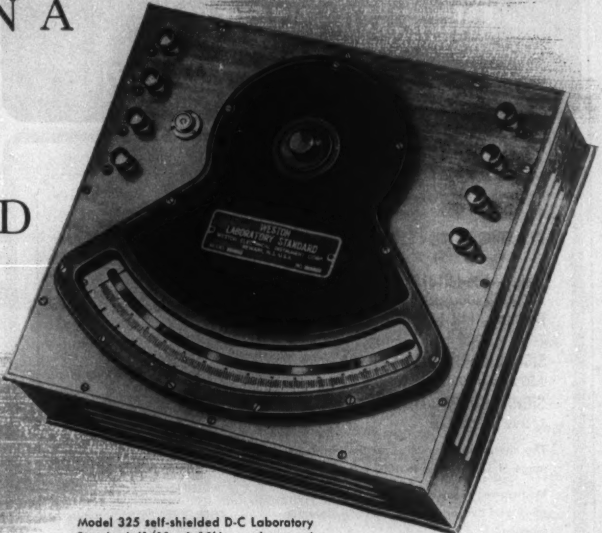
Aluminum Digest. A compact monthly publication covering all aluminum news is being made available to the entire metalworking industry by Reynolds Metals Company. *Reynolds Aluminum Digest* is a monthly publication containing 50 to 60 reviews of articles relating to aluminum that have been published in the technical press. In addition, the Digest carries a news summary of related current events, statistics on the aluminum industry, and patent listings. The main body of the periodical is broken down into separate sections covering developments in production methods, fabricating methods, properties, characteristics and standards, as well as new products and markets. To receive this publication monthly without charge address request to Desk ES, Reynolds Metals Company, 2500 South Third Street, Louisville 1, Ky.

Recording Tape Bulletin. Mechanical considerations in the use of thin base magnetic recording tapes are discussed in "Sound Talk" bulletin number 32 now available upon request from Minnesota Mining and Manufacturing Company, Dept. A6-141, St. Paul, Minn. The 4-page technical bulletin is illustrated with graphs and compares the physical properties of thin base and standard base recording tapes. Among considerations covered are conformability to recording head, acetate versus polyester films, inertia effect, and guiding and winding. In addition, four major points in use of thin base tapes are summarized.

Lighting Bulletins. Three new bulletins on lighting panels are available from Corning Glass Works. Bulletin *L-110-H* on Alba-lite panels, bulletin *L-110-A* on the new low brightness lens panel, and bulletin *L-110-C* on the new pattern number 83 Crysta-lite panel give complete product and photometric data. Tables for calculating illumination and light utilization levels are also included. The bulletins may be had free of charge by writing Lighting Sales Department, Corning Glass Works, Corning, N. Y.

(*Continued on page 68A*)

NO MEASURABLE ERROR IN A 5 OERSTED FIELD!



Model 325 self-shielded D-C Laboratory Standard (1/10 of 1%)—an improved instrument now replacing the world renowned Model 5.

The new Weston model 325 provides a new STANDARD of laboratory measurement

Another WESTON first... a self-shielded primary instrument standard that is unaffected by magnetic fields normally encountered in the modern laboratory. While the new Model 325 incorporates a special CORMAG® mechanism, the overall design provides an even far greater degree of shielding than that inherent in the basic core-magnet mechanism. In fact, tests show absolutely no measurable error in a 5 oersted field. Thus there is no need for positioning or mounting the instrument with reference to the earth's field; nor to take undue precautions when using it in close proximity to current carrying conductors. In addition, Model 325 is well compensated for normal room temperatures; and a vernier type corrector is provided for precise and rapid zero adjustment. This improvement in primary instrument standards is another example of the *forward thinking* and *continuous development* which have kept WESTON the instrument leader since 1888. For complete data on Model 325, or on other Weston instruments consult your nearest Weston representative, or write... *Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J.* A subsidiary of Daystrom, Incorporated.

WESTON
Secondary Standards
(¼ of 1%)

A DAYSTROM UNIT

WESTON
Instruments

RADIO
INTERFERENCE
AND FIELD INTENSITY
measuring equipment

Stoddart equipments are suitable for making interference measurements to one or more of the following specifications:

AIR FORCE—MIL-I-6181B
150 kc to 1000 mc
BuAer—MIL-I-6181B
150 kc to 1000 mc
BuShips—MIL-I-16910A (Ships)
14 kc to 1000 mc
SIGNAL CORPS—MIL-I-11683A
150 kc to 1000 mc
SIGNAL CORPS—MIL-S-10379A
150 kc to 1000 mc

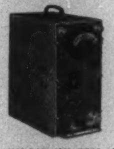
The equipments shown cover the frequency range of 14 kilocycles to 1000 megacycles.

Measurements may be made with peak, quasi-peak and average (field intensity) detector functions.

F.C.C. PART 15—Now in effect, the revised F.C.C. Part 15 places stringent requirements upon radiation from incidental and restricted radiation devices. Stoddart equipment is suitable for measuring the radiation from any device capable of generating interference or c-w signal within the frequency range of 14 kc to 1000 mc.

Write Stoddart Aircraft Radio Co., Inc., for your free copy of the new revised F.C.C. Part 15.

NM-10A (AN/URM-6B)
14 kcs to 250 kcs


NM-20B (AN/PRM-1A)
150 kcs to 25 mcs

NM-30A (AN/URM-47)
20 mcs to 400 mcs

NM-50A (AN/URM-17)
375 mcs to 1000 mcs

The **Stoddart NM-40A** is an entirely new radio interference-field intensity measuring equipment. It is the commercial equivalent of the Navy type AN/URM-41 and is tunable over the audio and radio frequency range of **30 CPS to 15 kc.** It performs vital functions never before available in a tunable equipment covering this frequency range. Electric and magnetic fields may be measured independently over this range using newly developed pick-up devices. Measurements can be made with a 3 db bandwidth variable from 10 CPS to 60 CPS and with a 15 kc wide broadband characteristic.

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Trade Literature

(*Continued from page 42A*)

Typewriter Tabulation Simplified. Adapted from the book, "Typing Simplified," this brochure outlines five easy steps for obtaining perfectly centered tabulation without complicated arithmetical calculations. Using a Remington typewriter with the exclusive perfect positioning scale with zero center, the process becomes even simpler with two of the five steps eliminated. Copies of this brochure, *R-8812*, are available at Remington Rand sales offices in all principal cities or by writing to Remington Rand, a Division of Sperry Rand Corporation, 315 Fourth Avenue, New York 10, N. Y.

Navigator Brochure. A new 20-page brochure concerning the Bendix-Decca Navigator system has been made available. Bendix has United States and Canadian rights for producing the equipment which was originally developed by Decca Navigator Company, Ltd., in England. The system gives accurate, reliable, and continuous position fixing for helicopters, fixed wing aircraft, ships, and land vehicles, and is ideally suited for terminal area traffic control and landing approach procedures. It will also have great value in air rescue work to locate aircraft in distress on land or at sea. The brochure explains how the Bendix-Decca system works, describes its component units, explains the technical side of the system, and explains its advantages in providing greater safety for passengers and aircraft, and economic flight operation. Copies of the brochure may be obtained by writing to J. H. Overholser, Pacific Division, Bendix Aviation Corporation, 11600 Sherman Way, North Hollywood, Calif.

Magnetic Core Manufacturing Booklet. A new technical bulletin has been published giving the latest helpful information on how both manufacturers and users of tape-wound or ferrite cores can benefit from using pulse control systems to test cores by digital techniques. Entitled "Pulse Patterns for Testing Cores" (technical bulletin *136*), the 16-page booklet discusses the current state of magnetic core manufacturing. The booklet shows how reliable testing procedures are a must, points out the need for equipment which not only tests how a core will meet specifications within all necessary ranges of tolerance, but also how it will eventually operate in the system for which it is intended. Block diagrams and timing diagrams illustrate how the country's leading manufacturers and purchasers of cores use Burroughs-built pulse control systems to fulfill testing needs. Free copies of technical bulletin *136* are available upon request to Burroughs Corporation, Electronic Instruments Division, 1209 Vine Street, Philadelphia 7, Pa.